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R.H.

FINAL REPORT FOR RESEARCH AGREEMENT
#INT-95080-RJVA
"Effect of Past Fuel and Stand Management on Severity of Wildfires in Mixed- and Stand Replacement Fire Regime Types"
UNIVERSITY OF MONTANA
FS Contact: Dr. Colin C. Hardy
CoOp Contact: Dr. Ron Wakimoto

AN ASSESSMENT OF THE KOOTENAI NATIONAL FOREST ORACLE DATA BASE FOR DETERMINING SUSCEPTIBILITY OF REGENERATION STANDS TO WILDFIRE. A CASE STUDY.

Prepared To Complete Obligations of
Research Joint Venture Agreement
NO. INT-95080-RJVA
Between USDA, FS Rocky Mountain Research Station
And
University of Montana

Dr. Ronald H. Wakimoto
Principle Investigator

And

Wendy L. Hall
Research Assistant
School of Forestry, University of Montana

May 22, 1998

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School of Forestry
University of Montana
Missoula, MT 59812
May 22, 1998

Colin Hardy
Rocky Mountain Research Station
Intermountain Fire Sciences Laboratory
P.O. Box 8089
Missoula, MT 59807

Dear Mr. Hardy:

Here is the final report on the Kootenai National Forest 1994 fire study. It meets the objectives outlined in the RJVA that Kevin Ryan and Steve Arno requested be addressed.

The queries conducted by myself and Regional Office personnel showed that there are 139 regeneration stands that were within the 1994 fire boundaries. These stands had met the KNF staff criteria of having undergone stand initiation within 20 years of the 1994 fires. However, this does not include the stands that had intermediate harvest treatments. Some stands had been harvested more than 20 years prior to 1994. Eighty five percent of my time was spent making sure I had the right stands. GIS coverages had minimal information in the attribute tables and no TSMRS attributes were present. Downloading and sorting the data on a PC were impossible. School of Forestry computers connected to a server had to be used to complete the queries.

I found very little data on fuel loadings and the reliability of this data was noted to be questionable by KNF staff. To my knowledge, there is no fuels monitoring program on the KNF or standardized data collection dealing with the effectiveness of activity fuels treatment. The fuel (tons/acre) field in the Oracle database was completely empty.

Appendix A of the report contains all of the raw data for the 139 stands. Appendix B contains tables and figures for each of the independent variables with the exception of stand position on slope. This variable is in the process of being derived through GIS functions.

The next steps in this study are to subset the data into the model building and model verification databases. Univariate analysis and model construction predicting the susceptibility of a regeneration stand to wildfire will be completed to meet the objectives of the MS thesis study.

Thank you for all of your help, cooperation, and support through out this study. Your expertise and encouragement have been greatly appreciated.

Sincerely

Wendy Lee Hall

Wendy Lee Hall

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EXECUTIVE SUMMARY

The 1994 lightning-caused fires on the Kootenai National Forest (KNF) provided a unique opportunity to explore the relationship between regeneration loss and the effectiveness of activity fuels management at reducing fire hazard. There were 139 stands within the KNF 1994 fire boundaries that had undergone stand initiation between 1974 and 1994. Reconnaissance surveys conducted after the fires documented regeneration loss in these stands. Those stands that had experienced, at least in some part, a stand-replacement fire and lost regeneration were coded as 4250 in the Oracle database. Not all stands that were coded 4250 were replanted. Those stands that had experienced an underburn, with no regeneration loss, were coded as 4981.

The first objective of this study was to assess the Oracle database as well as the other components of the Timber Stand Management Record System (TSMRS) for determining the effectiveness of fuel treatment. The second objective was to recommend data collection needs.

Each district on the KNF was visited and input was gathered from staff members on the variables that should be considered in this study, suppression efforts made during the fires, and availability of burn plans and fuels information. Eighteen variables were identified. Due to the lack of suppression resources, it was not possible to prevent regeneration loss when the fires entered the stands.

Prescribed burning was conducted on many of the regeneration stands as a means of treating harvest activity fuels to reduce hazard and for site preparation before regeneration was initiated. Burn plans for these treatments were not consistent within and among districts. Some plans were detailed while others were either not or non-existent. Pre and post treatment fuel load estimates were not reliable.

Downloading and sorting the TSMRS for the KNF proved to be difficult without the use of the Oracle program Files were very large and difficult to use without access to computers with large hard drives. Database queries performed by Regional Office personnel to determine the stands that were within the fire boundaries were the quickest and resulted in the least human error compared to my queries.

Results from this study indicate that specific activity fuels treatment data need to be gathered. Burn plans should be consistent through out the forest with the same types of information. This data should be gathered on the stand level and incorporated in GIS coverages to be utilized for landscape-level fuels management.

Data from this study will be used to construct and test a model predicting the susceptibility of a regeneration stand to wildfire as part of a master of science thesis study.

INTRODUCTION

During mid-August of 1994, the Kootenai National Forest (KNF) experienced the start of over 160 lightning-caused fires that burned approximately 53,000 acres (Kootenai National Forest, 1994). Resources became limited and suppression forces were not able to prevent regeneration loss in intensively managed stands.

Reconnaissance surveys conducted by USFS personnel during the summer of 1995 documented regeneration mortality in intensively managed forest stands. Some stands experienced a stand-replacement fire with regeneration mortality. Other stands seemed fire resistant experiencing only an underburn. Those stands that experienced the effect a stand-replacement fire were coded as 4250 in the Activities file of the Oracle database. The stands that were coded 4250 had mortality on at least some, but not necessarily all, of the regeneration in the stand. Stands that had regeneration mortality enough to reduce stocking to less than 300 trees per acre were replanted. Those stands that experienced fire that reduced the existing fuels, but did not create a change in the character of the stand were coded as 4981. These stands did not have any regeneration mortality or need replanting.

The US Forest Service is mandated to have regeneration stands "stocked" within five years after harvest. Large sums of time, money, and effort are applied in the nursery to grow seedlings, as well as in the planting of these harvested stands. Prediction of which stands are most susceptible to regeneration mortality due to wildfire would allow resource managers to apply the appropriate fuel treatments to help prevent regeneration loss.

The fire behavior models constructed by Albini (1976) identify the variables that predict the rates of spread, growth, flame front, and duff burned off by a fire. Some of the variables used to drive these models include: wind speed, slope, aspect, fuel characteristics, and temperature. Fire behavior and subsequent effects of a particular fire on vegetation are dependent on site characteristics such as slope and aspect as well as weather conditions during the fire.

A few researchers have investigated the relationship between fuel loads of managed and unmanaged stands. Omi and Kalabokidis (1991) examined the relationship between fuel loads, fire severity, and fire damage in extensively managed (not harvested) mature forests and intensively managed (clear-cut) stands that burned during the 1988 Greater Yellowstone fires. They found that mature extensively managed stands supported higher fuel loads and experience greater burn severity compared to intensively managed clearcuts.

Vihnanek and Ottmar (1994) investigated the effects of the 1988 Shady Beach wildfire, that occurred on the Willamette National Forest, on untreated and treated logging slash areas. Results showed that less fuel was consumed on units that had been treated compared to those that were untreated.

The authors of these studies reported differences in fuel loads before and after a wildfire. However, the effects of management activities and site characteristics on the susceptibility of a regeneration stand to wildfire were not studied. Thus, this study will determine if there is a relationship between site characteristics, management activities, and the need to replant regeneration stands as a result of the 1994 wildfires on the KNF.

Three ranger districts, Three Rivers, combined Libby, and Rexford of the KNF, were the focus of this study. These three ranger districts experienced the most fires and had the majority of regeneration stands within the 1994 fire boundaries (n=139). Site characteristic and management activity data from the Oracle database were used to assess susceptibility of regeneration stands to wildfire.

LITERATURE REVIEW

The objectives of site preparation include reducing harvesting fuel residue and exposing sufficient mineral soil to provide suitable conditions for regeneration. Slash that remains after harvesting posses a substantial hazard that can lead to catastrophic fires (Smith et al. 1997). Hazard, as defined by Deeming (1990) is:

> "a rating assigned to a fuel complex (defined by kind, arrangement, volume, condition, and location) that reflects the behavior and severity (of a fire) it would support, and/or the suppression difficulty it represents."

The probability of a large fire on an area is dependent on weather, topography, and the fuel hazard rating. Of these three variables, the only one that can be altered by management is fuels (Wood 1982).

Substantial quantities of time and funding are spent mitigating the hazards of activity fuels that occur as a product of timber harvest. Whether done by those who possess the contract or agency personnel, slash reduction is essential in order to reduce the occurrence of large fires. Deeming (1990) outlined the historical role that slash played in the spread and severity of large wildfires in the early 1900s. Recognizing this danger, state and federal agencies implemented hazard reduction laws and regulations that must be followed by landowners.

Harvest methods are prescribed to a stand to ecologically simulate a disturbance pattern (Smith et al. 1997). For instance, clearcutting is a regeneration method conducted to mimic severe disturbance and provide an environment for species that require a great amount of sunlight to regenerate. Other harvesting methods such as coppice, seed tree, and shelterwood are conducted to release regeneration that is present in the stand prior to harvest.

Likewise, site preparation methods are selected on an ecological basis (Smith et al. 1997). Treatments that are extensive through out the stand, such as broadcast burning, are conducted to allow species that are adapted to severe disturbance to regenerate. Intensive treatments that focus on only certain points in the stand, such as pile and burn, favor those species that regenerate under less severe conditions.

Bunnell and Christophersen (1982) discuss the use of different timber harvest methods in meeting fire management and silivicultural objectives. They point out that a given method does not necessarily meet the priorities of both interests and may conflict. For example, fire management personnel view the clearcut method as more preferable due to the ease and lower cost of burning the logging residuals. Seed tree harvesting would be the next preferable choice with shelterwood harvesting being the least preferable. Seed tree and shelterwood cuts are more difficult to burn without damaging the remaining trees and are more expensive. On the other hand, the silviculturist may prefer the seed tree cut because of the reduced regeneration costs.

Different timber harvest methods produce various quantities of activity fuels that must be treated with site preparation. Heald (1996) documents the amount of downed fuel produced by different management types. He found that clearcuts had the least down woody material (6-8 tons/acre) while stands that received group selection and individual tree selection methods had similar amounts of fuel compared to old growth stands (14-18 tons/acre).

Brown (1980) investigated the rates of spread and fire behavior of Douglas-fir *(Pseudotsuga menziesii)*, western larch*(Larix occidentalis)* and lodgepole pine *(Pinus contora)* slash in three silvicultural systems; clearcut, group selection, and shelterwood.

Conventional (lopping of tops and branches) and near-complete (everything is taken) utilization was implemented on each of the three systems. Calculations were made on 1 and 5-year-old downed woody fuels left after logging. Results showed a 3 to 4.5 times greater rate of spread (feet/minute) on those sites that had undergone the conventional harvest treatment compared to the near complete utilization. This increase in rate of spread was observed for both 1 and 5-year-old fuels. Fire line intensity (btu/ft/s) was approximately six times greater for units with the conventional method and 1-year-old fuels as opposed to the near complete utilization. Conventional methods with 1-year-old slash had intensities greater than 500 btu/ft/s at wind speeds of 10+ mph. These intensities represent an unacceptable hazard with high probabilities of spotting and crowning, and thus direct suppression tactics would not be possible. For fuels, which were 5-years-old, the increase in intensity was negated on both the conventional and near-complete utilization sites. Thus, within 5 years, the hazard of intensity would not be present.

Skinner and Weatherspoon (1996) explored the relationship between site preparation and regeneration damage following wildfire. They looked at differences in regeneration damage between broadcast burning, machine pile and burn, as well as no site preparation. Results indicated that broadcast burning resulted in little stand damage and no site preparation resulted in much greater damage. Mechanical piling and burning resulted in neither an increase nor decrease in regeneration damage. Furthermore, those stands that were broadcast burned suffered significantly less damage while stands receiving machine pile and burn treatments had suffered intermediate damage. Those

harvested stands that had no site preparation burned completely and severely resulting in total loss.

Deeming (1990) emphasized the importance of removing the fine and intermediate fuel size class (fuels < 1 inch in diameter) to reduce fire hazard. The successful ignition of a fire typically occurs in the fine fuels (< 1/4 inch in diameter). Furthermore, as Deeming (1990) states:

> "the rate at which a fire spreads is determined by the amount, continuity, and moisture contents of fine and intermediate-sized fuels".

However, the successful removal of the fine and intermediate fuel classes is best accomplished by controlled application of prescribed fire. The other fuel reduction methods such as mechanical and chemical, are not capable of removing these fuels. Prescribed burning is the only method that can remove fine and intermediate fuels Deeming (1990).

Several factors must be considered when writing site preparation plans for burning. They are: the age and species of the slash to be burned, duff and fuel conditions, the season in which the burn is planned, the aspect of the stand, and desired intensity of the burn. All of these factors play an essential role in determining the success of the burn and obtaining the desired conditions.

As fuels age they are effected by three processes: fuel compaction, foliage retention, and particle decomposition (Salazar and Bevins 1984). As the fuels compact, the finer fuels shift to the lower levels of the fuel bed resulting in an increase in bulk density, and a decrease in the depth of the total fuel bed. The result of this shift is a lower potential in fire behavior. (Salazar and Bevins 1984) Foliage retention effects the flammability of the cured slash. During the first few years after cutting, the red needles

and finer fuels are highly flammable. Particle decomposition is effected by the rate at which the slash ages (Salazar and Bevins 1984).

Salazar and Bevins (1984) researched the differences in the effects of slash aging on fire behavior for nine conifer species. Three fuel-loading levels (low, medium, and high) were compared for the nine species. Results showed that Engelmann spruce*(Picea engelmannii)* and grand fir *(Abies grandis)* compacted at the fastest rate. Western larch, lodgepole pine, and western white pine *(Pinus monticola)* had moderate, while Douglas-fir and western redcedar *(Thuja plicata)* had the slowest compaction rate. The amount of needle retention correlated proportionally with compaction rates. Spruce and western hemlock *(Tsuga heterophylla)* had the lowest retention amount while the pines had the greatest (Salazar and Bevins 1984). Fire behavior decreased over the ten-year period for both light and medium fuel-loadings. However, severe fire behavior was still evident for heavy fuel loads over the ten year period.

While the age of the slash greatly influences the potential fire behavior, the duff moisture content and season of burn directly correlate with the amount of fuel consumed by the burn.

The success or failure of a prescribed burn to produce the desired effects is directly determined by the duff moisture content of the stand at the time of the burn. Brown et al. (1985) points out that there are three ways duff consumption is expressed. One is by depth reduction of the duff, the second is the percentage of depth reduction, and the third is percentage of mineral soil exposed.

Brown et al. (1985) analyzed data from burn studies conducted in western Montana and northern Idaho. They found that the amount of duff depth reduction due to

the fire (in inches) increased linearly as the amount of moisture in the duff and total depth of duff decreased. For example, the greatest reduction was observed for the lowest moisture content and the deepest pre-burn duff depth.

However, Brown et al. (1985) noted that percentage duff depth reduction is easier to understand and use. The same relationship as that found for duff reduction was observed with percentage duff reduction. They also found that the amount of mineral soil exposure could be predicted with light (under 10 tons/acre) and heavy (greater than 10 tons/acre) fuel loads. The percent of soil exposure decreased linearly for both light and heavy fuel loads as percent moisture of the lower duff increased up to approximately 125%. However, the rate of increase in percent moisture content drops substantially after 125%.

Brown et al. (1991) also investigated the relationship between pre-burn fuel sizes and woody fuel consumed by fire. As with percent duff depth reduction, diameter reduction also is related in similar linear fashion. Pre-burn diameter, kind, and amount of surface fuels also appear to be related to diameter reduction, particularly in the larger fuels. Furthermore, diameter reduction in rotten pieces was greater than that of sound pieces.

There is much debate in the literature about the appropriate season to conduct a prescribed burn. While there are significant ecological implications of the resulting effects on the vegetation, there is also considerable evidence that the season of burn impacts the success of reducing the fuel hazard in harvested stands. In general, for the Northern Rockies, fall burns tend to have the greatest success in reducing fuel loads (Artley et al. 1978). The duff moisture content and moisture levels of the slash materials

are driest during this season. However, this generalization is not cut and dry. Artley et al. (1978) found that burning in the fall would not result in successful duff reduction if the duff moisture content is greater than 100 percent in western larch and Douglas fir. Furthermore, Ryan (1982) found that the desired reduction in fuel hazard depended on the average or drier-than-average summer and drier-than-average fall in the Douglas-fir/larch type. Little (1990) states that for Pacific Northwest forests, fuel loads can be reduced by burning during the spring when the conditions are moist and by removing large fuels prior to burning.

While fall burns tend to have a greater consumption of fuels, Williams and Rothermel (1992) point out that there is a greater risk of fires escaping the containment boundaries. They described the increase in fire danger related to the drying process that occurs from late spring to early fall and the effects of elevation. The pine/grass fuel types are the first to dry particularly on south aspects and low elevations. Thus the window of opportunity to prescribe burn in the pine/grass type while staying within allowable fire intensities, without loosing control of the burn, occurs in the spring time. In comparison, the windows of opportunity for Douglas fir and alpine fir extend much further into the summer. However, the rate of increase in intensity from a controllable burn to one in which offensive strategies need to be used changes quickly during late summer. With an increase in elevation and shift from southerly to more northern aspects, there is a time lag associated with the increased fire intensity (Williams and Rothermel 1992). Shearer (1975) also brings up the potential for late summer rains, which would extend the allowable burning period for the fir forest types.

Hall (1991) investigated how ignition patterns and intensity of the burn effected fuel consumption in broadcast burned clearcuts. The variables measured included woody fuel moisture content, diameter reduction of fuels, large and small woody consumption, and duff reduction. Results indicated that mass-ignited, high intensity fires actually had a lower amount of total fuel consumption than the moderate intensity fires. Hall (1991) explained that this difference was due to the extended length of time that the actual flaming front remained on the fuels. The length of time of active flaming was too short in a high intensity fire to accomplish the desired fuel reductions. Thus, ensuring adequate fuel moisture conditions is essential in obtaining the desired intensity. However, an advantage to high intensity fires is that the manager is able to limit the amount of particulate produced and comply with air quality guidelines (Hall 1991).

OBJECTIVES

The TSMRS and Oracle database were originally designed to keep track of silvicultural systems that were applied to stands. Stand exam and timber management information is kept in the TSMRS. For legal purposes, all activities done to a stand are documented in Oracle. With the change in management from a stand to an ecosystem landscape level, researchers were interested in the applicability of Oracle data for broader scale purposes. Thus, the objectives of this study as stated in Amendment #2 of the RJVA are as follows:

1. (Added) Evaluate the current National Forest databases for determining effectiveness of fuel treatments for moderating wildfire behavior.

2. (Added) Recommend data collection needs for fire management in a GIS-based Ecosystem Management context.

METHODS

Each ranger district was visited to gather information from the Timber Stand Management Record System (TSMRS) and from personnel regarding the regeneration stands that were effected by the 1994 fires.

The TSMRS has three components: index maps, stand folders, and the Oracle database. The index maps consist of orthophotos, topographic base maps, and overlay maps. The attributes of overlay maps include township and range, contour lines, streams, compartment and subcompartment boundaries, and delineated stands. The stand folders contain all the hard copy information about a stand. This includes stand examination data, silvicultural prescriptions, activity maps, and narrative reports. The Oracle database contains all the automated current and past stand information (USDA Forest Service, 1996).

During the first visit to each ranger district, the identification of regeneration stands that were within the fire boundaries was accomplished through the Forest Assessment of the 1994 fires, TSMRS, and personal communications. Copies of maps delineating subcompartment and stand boundaries were obtained to identify the effected regeneration stands. Duplicates of the reconnaissance surveys conducted in 1995 were acquired. Narrative descriptions of the fire events were recorded from suppression personnel. Color copies of aerial photos taken of the fires were gathered from the supervisor's office. A Digital Elevation Model provided by the Supervisor's Office was used to determine the position of each stand on the slope.

A second visit to the districts was conducted to discuss the study plan, and relevant variables that should be included in the study. On a third visit, information on

suppression tactics (if any) applied to the regeneration stands was gathered from discussions with fire staff. Stand folders were examined for pre and post harvest surveys, sivicultural prescriptions, and any burn plans containing information on fuel loads. Weather station records, energy release component (ERC) and burning index (BI) data was collected.

In order to insure that all applicable regeneration stands were identified, several database checks were conducted. The Regional Office conducted a query of the entire KNF Oracle database and provided a list of regeneration stands that had experienced fire. This query was based on the harvest and fire codes. Each of the districts were also asked to conduct the same query. Using a copy of the KNF Oracle database provided by the Regional Office, I sorted the stands that had harvest activities and fire codes. These query lists were compared to check for discrepancies. Once a list of all regeneration stand numbers in this study was determined, a database file with the study variables was constructed (Appendix A). Tables and figures showing the frequency distribution of each independent variable identified in this study were constructed (Appendix B).

DESCRIPTION OF CODES

4111 Patch Clearcut. A modification of the clearcutting method (the removal of the entire standing crop, live and/or dead) where patches out of an individual stand boundary are clearcut. Patch clearcuts often enable for regenerating even-aged stands which cannot be reproduced by natural seeding if all the timber is removed in a single cutting. Only a portion of the stand's acres are reported as accomplished following a patch clearcut. If a patch clearcut is 10 acres or larger, consideration should be given to creating a new stand.

4113 Stand Clearcut. Removal of the entire standing crop (live and/or dead) within a delineated stand boundary for the purpose of creating a new, even-aged stand. The entire stand acres are generally reported as accomplished for a stand clearcut.

4114 Clearcut with Reserves. A clearcutting method in which varying numbers of reserve trees (live trees, pole-sized or larger) are not harvested to attain goals other than regeneration.

4131 Shelterwood Seed Cut. Removing trees in a mature stand so as to effect permanent opening of its canopy (if there was no preparatory cutting to do this) and so provide conditions for securing regeneration from the seed of trees retained for the purpose in a shelterwood system.

4132 Seed Tree Seed Cut. Removing trees in a mature stand so as to effect permanent opening of its canopy (if there was no preparatory cutting to do this) and so provide conditions for securing regeneration from the seed of trees retained for the purpose in a seed tree system.

4133 Shelterwood Seed Cut with Reserves. Removing trees is a mature stand so as to effect permanent opening of its canopy (if there was not preparatory cutting to do this) and so provide conditions for securing regeneration from the seed of trees retained for that purpose in a shelterwood system. Any tree or group of trees left unfelled and kept for part of or the entire next rotation are reserves. (In other words, if there is no intention to remove the overstory, the shelterwood seed cut with reserves is the appropriate code. If part of the overstory will be removed at a later date, shelterwood seed cut is the appropriate code. A shelterwood final cut with reserves will be scheduled.)

4141 Shelterwood Removal Cut. Removing trees between the seed cutting and the final cutting under a shelterwood system, so as to gradually reduce the shelter and admit more light to aid the regenerated crop to secure further recruitment.

4149 Seed Tree Final Cut with Reserves. Removal of the seed bearers after regeneration is considered to be established under a seed tree system. Any tree or

group of trees left unfelled and kept for part of or the entire next rotation are reserves.

4250 Natural Changes. Changes in vegetative character or volume (generally resulting in new stand delineations) due to natural occurrences such as floods, landslides, insect epidemic, fire, and so forth. This does not include changes to inventory due to normal mortality. Method of accomplishment must always be coded with activity code 4250. Valid codes are 304 – wildfire; 306 – insect and disease; and 307 – wind. Natural changes are included on the "Needs Report" when they are followed by a planned regeneration treatment.

4431 Plant. The formation of a forest by setting out wild or nursery-grown plants. Planting may be done with bare-root stock, container stock, rooted cuttings, or material raised from tissue culture.

4432 Replant. Anytime an area is planted after initially being planted, the activity is coded as a replant.

4451 Natural Regeneration. The renewal of a tree crop by volunteer growth. The process results in restocking of the area of concerned.

4465 Slashing. Cutting back unwanted, competing vegetation in a area. Slashing is a step toward site preparation, but is not itself, a site preparation activity. It includes mistletoe whip removal unless the mistletoe whip removal is accomplished with I&D funds (fund code 07). If I&D finances mistletoe whip removal, the activity is 4583, dwarf mistletoe control, with method of accomplishment 524, slashing.

4471 Site Preparation for Planting-Burning. A general term for removing unwanted vegetation, slash, stumps, roots, and stones, from a site. Site preparation is accomplished by prescribed burning for the purpose of planting the area.

4473 Site Preparation for Planting-Mechanical. Same as 4471 except site preparation is accomplished by mechanical manipulation of the vegetative cover to reduce plant competition for the purpose of planting the area.

4491 Site Preparation for Natural Regeneration-Burning. Same as 4471 except site preparation is done for the purpose of natural regeneration.

4492 Site Preparation for Natural Regeneration-Mechanical. Same as 4473 except site preparation is done for the purpose of natural regeneration.

4975 Burn Dozer Piles. Physically burning the dozer piles.

4977 Burn Grapple Piles. Physically burning the grapple piles.

4978 **Broadcast Burn.** A prescribed fire burning through a continuous fuel cover that is designed to treat one or more land management objectives.

4979 **Jackpot Burn.** A prescribed fire designed to treat fuel accumulations in small concentrations. This is a spotty treatment which can achieve objectives such as hazard reduction or disease control.

4980 **Understory Burn.** A type of broadcast burn designed to reduce fuel accumulations beneath an overstory tree canopy (natural stand, shelterwood, seed tree, and so forth) and be designed to achieve specified levels of site preparation.

4981 **Wildfire.** Any wildland fire not designed and managed as a prescribed fire within an approved prescription. A wildfire that effectively reduces existing fuels, but does not change the character of the existing stand should be coded 4981. A stand replacing wildfire will result in a new stand delineation and will be coded as 4250 (Natural Change).

4982 **Lopping.** A method of reducing average fuel height to an acceptable level, thereby reducing fire intensity and increasing natural fuels abatement.

4983 **Mechanical Piling.** Any mechanical piling of fuels, other than dozer piling. This includes piling cable landings or piling in cable corridors as a fuel treatment.

4984 **Dozer Piling.** Fuel treated by dozer piling slash, includes landings.

RESULTS AND RECOMMENDATIONS

Objective 1. Evaluate the current National Forest databases for determining effectiveness of fuel treatments for moderating wildfire behavior.

Table 1 lists the variables that were identified through discussions with KNF staff. Appendix B contains tables and figures the frequency distributions for each of these variables. Appendix A contains the entire database for this study.

Table 1. Listing of relevant variables identified by KNF staff.

#	VARIABLE
1	Slope
2	Aspect
3	Elevation
4	Habitat Type
5	Stand Size Class
6	Year of Origin
7	Fuel Load
8	Stand Position on Slope
9	Type of Fuel
10	Trees/Acre
11	Forest Type
12	Type of Treatment
13	Equipment Type
14	ERC
15	BI
16	Thinning Prior to 1994
17	Vegetative Response Unit
18	Weather

Not all variables were found so these were not included in the data set for further analysis. Stand size class information was updated after the 1994 fires. Many of the stands size classes changed to non-stocked. Unlike the activity files, the basic stand data

file (record type B) does not contain the historic data. Rather only the most recent information is kept in the file.

The stand year of origin, as defined by KNF staff, is the same as reforestation year in the Oracle database. Reforestation year is defined as the year when stand initiation actions were taken. Fuel load data and type of fuel was completely absent in the Oracle database. Stand position on the slope was also absent. It is my understanding that stand photo interpretation was done during the 1960s and 1970s. However, when stand exam programs were implemented this information was deleted from the database.

Type of treatment included harvest, fuel, and site preparation. In the database constructed for this study (Appendix A), fuel treatment was separated into three treatments: fuel treatment 1, 2, and 3 respectively. These fuel treatments were separated by type and the sequence in which they occurred. Fuel treatment 1 is all of the treatments that dealt with moving the fuel (lopping, mechanical piling, and dozer piling) prior to a burn treatment. If a fuel treatment 1 occurred, then it was the first treatment to occur in the sequence. Fuel treatment 2 and 3 are the type of burn treatments that were conducted to the fuels (burn dozer piles, burn mechanical piles, broadcast, jackpot, and understory burn).

Out of 139 stands 57 (41%) and 58 (42%) of these stands had missing harvest method and harvest equipment type respectively. Likewise, 15 (11%) and 23 (17%) out of 139 stands had missing site preparation method and blank entries respectively. Equipment type used to accomplish harvesting and site preparation was not completely recorded.

Only three stands in the study had thinning done prior to 1994 which is too small a sample size to include precommercial thinning in the study.

After further discussion with the researchers involved in this study, ERC, BI, and Weather were excluded from this study. Although an important component to fire behavior, these three variables cannot be tied directly to each of the 139 stands. However, a discussion of the weather and fire conditions prior to the 1994 fires will be included in the thesis.

The number of stands that were within the 1994 fire boundaries and the selection criteria are presented in Table 2.

Table 2. The number of stands in this study subsetted by selection criteria.

CRITERIA	# of stands
Entire KNF Harvest before 1994 and fire 1994 (4250 or 4981)	265
Without Cabinet or Murphy Lake RD	255
Stand Initiation 1974-1994/Without Intermediate Harvest Methods	157
Without Little Wolf Fire	139

The queries conducted by the RO and myself determined that there were 265 stands within the fire boundaries on the KNF that had been undergone harvesting prior to 1994. Based on recommendations from RMRS, this study focussed on three ranger districts: Three Rivers (D4, Troy), Rexford (D1, Eureka) and combined Libby (D6). Murphy Lake (D3) and Cabinet (D7) were excluded due to the low number of stands (n=10). According to district personnel, a regeneration stand is no longer a regeneration stand 15-20 years after stand initiation. Thus, stands that had undergone stand initiation prior to 1974 were not included in this study. As recommended by collaborative

researchers, stands that had undergone intermediate harvest methods were also excluded. Lastly, as recommended by Libby district personnel, stands that were in the Little Wolf fire were also excluded. They felt that given the observed fire behavior during the Little Wolf fire, none of the fuel treatment would have prevented regeneration loss.

Table 3. Number of stands by ranger district and fire code.

DISTRICT	REGEN LOSS (4250)	NO REGEN LOSS (4981)	TOTAL
Rexford (D1)	29	37	66
Three Rivers (D2 & D4)	49	1	50
Libby (D5 & D6)	14	9	23
TOTAL	**92**	**47**	**139**

Things I've Learned

1. The original stand list obtained during the first district visit was not accurate because it was not obtained systematically. Staff memory rather than a query of the database was used to obtain this list.

2. Libby RD had the fire name entered as a field in the database. This made obtaining the stand list easy.

3. When I originally started this study in January of 1996, the database was not fully updated with fire salvage work. The March 5, 1998 file that I obtained from the RO had the salvage/fire name in the database. Prior to this, I had no way of linking the stand number to a specific fire. The GIS coverages did not have this link as well.

4. GIS fire layers only had stand ids and fire perimeter in the stand attribute file. No link to the TSMRS.

5. Three Rivers RD was asked in January of 1996 as well as April of 1997 to complete a query on harvest prior to 1994 and fire in 1994. This query was not completed. They did provide a hard copy of all harvested stands on the district and all stands that had one of the fire 1994 codes. However, these were not a subsetted list with just the stands that had harvest prior to and fire in 1994.. This made it very difficult to sort out which stands were in the study and left room for human error. The same query was asked of Rexford RD. They provided a list of stands that had a harvest performed prior to 1994 and fire in 1994. Rexford met

this request within two weeks. The GIS staff stated that it took them 2-3 hours to run the query and print out the stand information requested.

6. I explained to the SO the information needed and asked if the SO would run the query on the entire forest. They stated that they did not have time and that I would have to run the query myself. They provided a tape with the entire Oracle database for the KNF.

7. Downloading the files and sorting the data myself proved to be very difficult. The files were huge and required being stored and manipulated on the School of Forestry server. At one point in time, I was using close to 400MB of hard disc space when I split the database into manageable units. Opening the files also proved to be difficult. The files were too large to open in Excel and required a program editor or software such as SAS to open. I did not have access to the Oracle program to complete the query myself.

8. A Fortran program was need to sort data into columns. The Oracle database is compressed in order to save space. Thus, the data is in a continuous string and columns were not tab delineated. Using the file description of the TSMRS with the column positions within each record type, a Fortran program was written to extract the selected database records.

9. It became evident that the main issue during this study was not data quality but rather data accessibility. Eighty five percent of my time was spent making sure that I had the right stands for this study. It was not until February of 1998 that I knew that the useable number of stands equaled 139. Once I was sure I had the correct stand list, the database for this study was constructed by keying in by hand the hard copy stand data provided by the RO and districts (Appendix A). Sorting from the Oracle data file would have taken a greater length of time with a risk of human error.

10. It was discovered in November of 1997 that the RO was capable of running the query. They ran the query for the entire KNF. They were able to complete the query in 1-2 hours. They also provide hard copies of stand information on the stands found in the query. The RO and my query found the same stands to be in the study.

11. The Oracle database works best for the stand level approach. Using Oracle on the Landscape level would be very difficult and would require someone who is an expert at using Arc/Info and ArcView, as well as expert knowledge of computer programming languages.

12. Fuels data for this study was completely absent in the Oracle database and minimal in the stand files. The information in the stand files was not consistent between or within a district. Some files had burn plans and silvicultural prescriptions that mentioned fuel loadings prior to treatment. However, this was

not the case very often. Furthermore, if there was a mention of the fuel load there was no mention of the amount of residue after treatment. Many times the burn plans were a blanket prescription for several units with the same load estimate for each unit. District staff noted that these estimates were ocular and not reliable. The fuel load (tons/acre) field in the Oracle database is not a mandatory field to be filled.

13. The position the stand is on the slope is also not a mandatory field and was completely vacant.

14. Method of accomplishment and equipment type used for harvesting and site preparation are not mandatory fields as well.

Objective 2. Recommend data collection needs for fire management in a GIS-based Ecosystem Management context.

1. This study hinged on the effectiveness of activity fuels treatment at reducing fire hazard. Fuels data were nonexistent. Thus, it is recommended that pre and post fuels treatment data be collected in order to estimate size, arrangement, and quantity of residual fuels.

2. Burn plans should contain information on fire behavior, weather conditions, fire intensity, and fire severity during the burn.

3. The objectives of the burn and whether those objectives were accomplished should be mentioned.

4. Burn plans should have the same components with a standardized format for all districts.

5. Fuel loading or hazard estimates on the stand level should be used to construct GIS coverages in order to assess fire management priorities on a landscape level.

Further Work to be Completed

Final data analysis and model construction will be completed to meet the obligations of the thesis study. The following two objectives and hypothesis will be tested.

1. Construct a model predicting the proportion (percent) of tree acres killed in a regeneration stand by wildfire (dependent variable) as a function of site characteristics and management activities (independent variables).

Ho: Site characteristics and management activities in regeneration stands are not functionally related to the proportion of tree acres killed in a regeneration stand.

H_1: not Ho

2. Construct a validation model to test the prediction model constructed under objective number one.

Ho: $\beta_0 = 0$ and $\beta_1 = 1$

H_1: not Ho

Objective and hypothesis number one will be accomplished by the construction of a model using logistic regression techniques outlined by Loftsgaarden and Andrews (1992). The dependent variable (Y) will be the proportion of tree acres killed in a regeneration stand by wildfire. The independent variables (Xs) will be site characteristics and management activities. The selection of the independent variables thought to depict this relationship will be based on suggestions from Kootenai National Forest personnel, literature review, and preliminary data analysis such as the construction of scatter diagrams and calculation of correlation coefficients. A sub-sample, randomly selected from the total population of regeneration stands in this study, will be used to construct the prediction model.

Objective and hypothesis number two will be tested by using the remaining regeneration stands as the model verification database. The observed values of Y will be

plotted against the predicted values of Y to test simultaneously if the y-intercept is equal to zero and the slope equal to one. Residual analysis (observed - predicted) will be conducted to test for normal and independently distributed residuals. Scatter plots will be constructed to look for problems with normality such as multicollinearity, heteroscedasticity, and autocorrelation. Transformations will be performed on variables if problems are encountered.

LITERATURE CITED

Albini, F.A. 1976. Estimating wildfire behavior and effects. USDA For. Serv. Gen.Tech. Rep. INT-30, 92p. Intermountain Forest and Range Experiment Station, Ogden, Utah 84401.

Artley, D.K., R.C. Shearer, and R.W. Steele. 1978. Effects of burning moist fuels on seedbed preparation in cutover western larch forests. USDA For. Serv. Res. Pap. INT-211, 14p.

Brown, J.K. 1980. Influence of harvesting and residues on fuels and fire management. *In* USDA Forest Service. Environmental consequences of timber harvesting in Rocky Mountain coniferous forests. USDA For. Serv. Gen. Tech. Rep. INT-90, 526 p.

Brown, J.K., M.A. Marsden, K.C. Ryan, and E.D. Reinhardt. 1985. Predicting duff and woody fuel consumed by prescribed fire in the Northern Rocky Mountains. USDA For. Serv. Res. Pap. INT-337. 1985. 23 p.

Brown, J.K., E.D. Reinhardt, and W.C. Fischer. 1991. Predicting duff and woody fuel consumption in Northern Idaho prescribed fires. For. Sci. Vol. 37. No. 6. p 1550-1556.

Bunnell, D.L. and A.L. Christophersen. 1982. Developing fire and silvicultural prescriptions for site preparation, an example. *In* Site preparation and fuels management on steep terrain. Proceedings of a symposium held February, 1982 in Spokane, Washington. Baumgartner, D.M. editor. Washington State University, Cooperative Extension, Pullamn, Washington 99164-6230. p 41-45.

Deeming, J.E. 1990. Effects of prescribed fire on wildfire occurrence and severity. *In* Walstad, J.D., S.R. Radosevich, and D.V. Sanberg. editors. Natural and prescribed fire in the pacific northwest forests. Oregon University Press. 317pp.

Hall, J. N. 1991. Comparison of fuel consumption between high intensity and moderate intensity fires in logging slash. Northwest Science, Vol. 65, No. 4, p 158-165.

Heald, R.C. 1996. Fuel loading consequences of alternative silviculture treatments. *In* Proceedings, 17th annual forest vegetation management conference. January 1996, Redding California. P 74-86.

Kootenai National Forest, November 1994. Forest Assessment of 1994 Major Fires. 23 p. plus appendices.

Little, S.N. 1990. Conserving resources and ameliorating losses from prescribed burning. *In* Walstad, J.D., S.R. Radosevich, and D.V. Sanberg. editors. Natural and prescribed fire in the pacific northwest forests. Oregon University Press. 317pp

Loftsgaarden, D.A. and P.L.Andrews 1992. Constructing and testing logistic regression models for binary data: applications to the National Fire Danger Rating System. USDA For. Serv. Gen. Tech. Rep. INT-286, 36p. Intermountain Forest and Range Experiment Station, Ogden, Utah 84401.

Omi, P.N. and K. D. Kalabokidis. 1991. Fire damage on extensively vs. intensively managed forest stands within the north fork fire, 1988. Northwest Science, Vol. 65, No. 4 : 149-157.

Ryan, K.C. 1982. Burning for site preparation on steep-slope helicopter-logged clearcuts in northwestern Montana. . *In* Site preparation and fuels management on steep terrain. Proceedings of a symposium held February, 1982 in Spokane, Washington. Baumgartner, D.M. editor. Washington State University, Cooperative Extension, Pullamn, Washington 99164-6230. p 25-33.

Salazar, L. A. and C.D. Bevins. 1984. Fuel models to predict fire behavior in untreated conifer slash. USDA For. Serv. Res. Note. PSW-370, 6p.

Shearer, R.C. 1975. Seedbed characteristics in western larch forests after prescribed burning. USDA For. Serv. Gen. Tech. Rep. INT-167, 25p.

Skinner, C.N., and C.P. Weatherspoon. 1996. Planting characteristics affecting damage from wildfire. *In* Proceedings, 17th annual forest vegetation management conference. January 1996. Redding California. P 137-142.

Smith, D.M. et. al. 1997. The practice of silviculture: applied forest ecology. Ninth edition. John Wiley and Sons, Publishers. Chapters 7 and 8. pp 161-233.

US DA Forest Service-Region 1. 1996. Timber Management Control Handbook. R1 Amendment, 2409.21e-92-1: 160p.

Vihnanek, R.E., and R.D. Ottmar. 1994. When logged units burn in a wildfire, does slash treatment mitigate effects? *In* Proceedings of the 12th conference on fire and forest meteorology; 1993 October 26-28; Jekyll Island, GA. Bethesda, MD: Society of American Foresters: 709-714.

Williams, J.T. and R.C. Rothermel. 1992. Fire dynamics in northern rocky mountain stand types. USDA For. Serv. Res. Note INT-405. 4 p.

Wood, D.B. 1982. Fuel management's potential for reducing frequency of large fires in t he Northern Rockies. Jour. Forestry, Feb. p 96, 105 – 107.

APPENDIX A

RAW DATA

	stand #	F94	H1	H1Yr	hma	hequty	Refor	Ref Yr	SP	spma	spequty	F T.1	FT1MO	F T.2	FT2M0	F T.3	FT3M0	TPA
1	10606021	4250	4111	1974	200	119	4451	1975	4493	200	107	4984		4975	10			1000
2	10606027	4981	4113	1974	200	119	4451	1975	4493	200	107	4984		4975	10			450
3	10606030	4981	4132	1981	200	107	4451	1981	4493	200	107	4984		4975	10			800
4	10606031	4981	4132	1980	200	119	4451	1981	4493	200	107	4984		4975	10			900
5	10606034	4981	4131	1980	200	119	4451	1981	4493	200	107	4984		4975	10			900
6	10606110	4981	4132	1980			4431	1981	4493	200	107	4984		4975	10			900
7	10702023	4250	4132	1979	200	119	4431	1981	4491	305	101			4980	9			2550
8	10702064	4981	4132	1990	200	119	4451	1991	4491	305	101			4980	6			683
9	10702066	4981	4132	1990	200	119	4431	1992	4471	305	101			4980	5			300
10	10704023	4250	4131	1978			4451	1979	4491	301	100			4978	6			250
11	10704024	4250	4131	1978			4451	1979	4491	301	100			4978	6			500
12	10704026	4981	4132	1980			4431	1986	4491	305	100			4978	9			400
13	10704027	4981	4131	1979			4431	1981	4471	301	101			4978	9			900
14	10704028	4981	4114	1980			4451	1980	4493	200	107	4984		4975	10			3875
15	10704030	4981	4131	1979			4451	1980	4471	301	101			4978	9			900
16	10704034	4981	4131	1980			4451	1980	4493	200	107			4975	10			800
17	10704035	4981	4131	1979			4451	1980	4493			4984		4975	10			500
18	10704036	4981	4132	1980			4431	1981	4493	200	107	4984		4975	10			900
19	10704048	4981	4132	1979			4431	1986	4493	200	107	4984		4975	10			628
20	10704078	4981	4132	1990	200	119	4451	1991	4491	305	101			4980	6			402
21	10704080	4981	4132	1990	200	119	4431	1992	4471	305	101			4980	5			300
22	11104013	4981	4113	1989	200	107	4451	1989	4491	301	101			4978	9			664
23	11104018	4981	4113	1980			4451	1979	4493	302	107	4984						640
24	11104019	4981	4113	1981			4451	1981	4493	302	107			4975	10			140
25	11104024	4981	4113	1977	200	119	4451	1978	4493	302	107	4984						1725
26	11104032	4981	4113	1989	200	119	4451	1989	4491	301	101			4978	9			165
27	11104033	4981	4132	1989	200	119	4451	1989	4491	301	101			4978	9			300
28	11104109	4981	4132	1989	200	119	4451	1989	4491	301	101			4978	9			226
29	11104111	4250	4149	1993	200	119												
30	11202005	4981	4111	1973	200	119	4451	1975	4493	200	107			4975	6	4975	10	1767
31	11202029	4250	4132	1989	200	107	4451	1989	4491	301	101			4978	9			246
32	11202030	4250	4132	1988			4451	1989	4491	301	101			4978	6			426
33	11202031	4250	4132	1988	200	107	4451	1989	4491	301	101			4980	5			296

	stand #	F94	H1	H1Yr	hma	hequty	Refor	Ref Yr	SP	spma	spequty	F T.1	FT1MO	F T.2	FT2M0	F T.3	FT3M0	TPA
34	11202032	4250	4132	1989			4451	1990	4493	302	101	4984		4975	10			817
35	11202033	4250	4132	1988	200	107	4451	1989	4491	301	101			4978	9			160
36	11202034	4250	4113	1988	200	107	4451	1989	4491	301	101			4978	5			238
37	11202035	4250	4132	1989	200	119	4451	1989	4491	301	101			4978	9			200
38	11202036	4250	4132	1989	200	119	4451	1989	4491	301	101			4978	9			
39	11202037	4250	4132	1988	200	119	4451	1989	4491	301	101			4978	6			188
40	11202038	4250	4132	1989	200	107	4451	1990	4493	302	107	4984		4975	10			339
41	11202039	4250	4113	1988	200	107	4451	1989	4491	301	101			4978	5			101
42	11203001	4250	4113	1973	200	119	4451	1975	4491	301	101			4978	6			600
43	11203002	4981	4113	1973	200	119	4451	1975	4493	200	107	4984		4975	10			750
44	11203003	4981	4111	1974	200	119	4451	1976	4491	301	100			4978				900
45	11203004	4981	4113	1974	200	119	4451	1975	4471	301	100			4978	6			600
46	11203005	4250	4111	1974	200	119	4451	1974	4491	301	100			4978	6			900
47	11203059	4250	4132	1989	200	119	4451	1990	4491	301	100			4978	8			695
48	11203060	4250	4113	1988	200	107	4451	1989	4491	301	101			4978	5			127
49	11203061	4981	4113	1989	200	119	4451	1990	4491	301	101			4978	8			388
50	11203065	4250	4113	1988	200	107	4451	1989	4491	301	101			4978	5			144
51	11203066	4250	4132	1988	200	107	4451	1989	4491	301	101			4978	9			708
52	11203067	4981	4132	1987	200	119	4431	1988	4491	301	101			4978	5			301
53	11204001	4250	4111	1974	200	119	4451	1974	4491	301	101			4978	6			700
54	11204008	4981	4113	1978	200	107	4431	1979	4493	301	100			4975	8	4978	10	2018
55	11204009	4981	4111	1979	200	119	4451	1979	4491	301	101			4978	9			600
56	11204010	4981	4111	1977	200	119	4451	1977	4491	301	101			4978	9			600
57	11204011	4981	4111	1977	200	119	4451	1978	4471	301	100			4978	9			600
58	11204012	4981	4113	1976	200	119	4451	1976	4471	301	100			4978	9			1176
59	11204013	4981	4113	1976	200	119	4451	1977	4473	200	107	4984		4975	10			1387
60	11204105	4250	4132	1988	200	119	4451	1989	4491	301	101			4978	9			391
61	11204107	4250	4132	1990	200	119	4451	1991	4491	301	101			4978	6			241
62	11204108	4250	4132	1983	200	119	4451	1988	4491	301	101	4980	9	4978	10			600
63	11303025	4250	4131	1980			4451	1980	4493	200	107	4984		4975	11			500
64	11303026	4250	4113	1980	200	119	4431	1984	4473	200	107	4984		4975	10			700
65	11303027	4250	4132	1980	200	119	4431	1984	4473	200	107	4984		4975	10			500
66	11304098	4981	4132	1980	200	119	4431	1984	4473	302	107	4984		4975	10			500

	stand #	F94	H1	H1Yr	hma	hequty	Refor	Ref Yr	SP	spma	spequty	F T.1	FT1MO	F T.2	FT2M0	F T.3	FT3M0	TPA
67	40504128	4250	4113	1963	200		4451	1977										300
68	41208120	4250	4113	1961	200		4451	1977	4491	301	113			4978	10			300
69	42401115	4250	4113	1970	200		4451	1974	4493	200	107	4984		4975	10			340
70	42402103	4250	4113	1983	200	119	4451	1984	4493	200	107	4984		4975	10			800
71	42402117	4250	4131	1981	200		4451	1982	4493	200	107	4984		4975	10			500
72	42402120	4250	4113	1983	200	119	4431	1987	4473	200	107	4984		4975	10			558
73	42503145	4250	4131	1990	200	119	4451	1991	4493	200	108	4983						376
74	42504110	4250	4131	1990	200	119	4451	1991	4493	200	108	4983						376
75	42504115	4250	4131	1991		119	4451	1991	4493	200	108	4983						350
76	42504136	4250	4131	1992	200	119	4451	1992				4983		4977	10			213
77	42504144	4250	4131	1991		119	4451	1993						4977	6			347
78	42505114	4250	4131	1991		119	4451	1991										347
79	42701122	4250	4131	1984	200	118	4465	1984	4473	200	107	4984		4975	10			725
80	42701126	4250	4131	1984	200	119	4451	1984	4493	200	107	4984		4975	10			400
81	42701134	4250	4131	1984	200	118	4431	1990	4471	301	113			4980	10			386
82	42701136	4250	4131	1984	200	119	4451	1985	4493	200	107	4984		4975	10			627
83	42701139	4250	4131	1984	200	118	4451	1985	4471	301	113			4980	9			622
84	42701144	4250	4131	1984	200	119	4451	1985	4491	305	113			4980	9			470
85	42701147	4250	4132	1987	200	107	4451	1988	4493	200	107	4984		4975	12			671
86	42701153	4250	4113	1986	200	107	4451	1986	4493	200	113			4984	9	4975	10	375
87	42701154	4250	4113	1989	200	120	4431	1990	4491	301	113			4978	10			500
88	42704119	4250	4132	1987	200	107	4451	1988	4493	200	107	4984		4975	12			671
89	42704122	4250	4113	1986	200	120	4451	1989	4491	301	113			4978	10			242
90	42704136	4250	4113	1986	200	119	4451	1986	4493	200	113	4984		4975	10			555
91	42704140	4250	4113	1987	200	107	4431	1989	4471	301	113			4978	10			400
92	42704141	4250	4113	1987	200	107	4451	1988	4493	200	107	4984		4975	12			304
93	42704171	4250	4113	1987			4431	1989	4471	301	113			4978	10			600
94	42704172	4250	4113	1979	200	119	4451	1979	4471	301	113			4978	9			600
95	42704178	4981	4132	1986	200	107	4451	1986	4493	200	107	4984		4975	11			608
96	42803112	4250	4113	1981			4431	1983	4471	301	113	4984		4978	9	4975	10	500
97	44406146	4250	4113	1985			4431	1987	4471	301	113	4982		4978	10			349
98	44501242	4250	4141	1984			4431	1985	4473	200	107			4978	10			308
99	45102166	4250	4113	1983			4431	1988	4471	301	113			4978	10	4980	10	390

	stand #	F94	H1	H1Yr	hma	hequty	Refor	Ref Yr	SP	spma	spequty	F T.1	FT1MO	F T.2	FT2M0	F T.3	FT3M0	TPA
100	45302121	4250	4113	1981			4431	1983	4471	301	113			4978	9	4978	8	820
101	45402175	4250	4113	1961			4431	1991										420
102	45404122	4250	4113	1960			4431	1981										300
103	45404123	4250	4113	1961			4432	1983										300
104	45404142	4250	4113	1961			4431	1983	4471	301	113							350
105	45404146	4250	4113	1962			4432	1981										450
106	45504105	4250	4132	1990	200	119	4451	1990	4491	305	113			4980	9			29
107	45504114	4250	4113	1990	200	119	4431	1992	4471	301	113			4978	4			397
108	45505118	4250	4113	1990	200	120	4431	1994	4471	301	113			4979	5			268
109	45505122	4250	4132	1990	200	119	4451	1990	4491	305	113			4980	9			29
110	45505125	4250	4113	1990	200	119	4431	1992	4471	301	113			4978	4			397
111	45505127	4250	4132	1988			4431	1991	4471	301	113			4980	5			346
112	45505129	4250	4132	1988			4431	1990	4471	301	113			4980	5			322
113	45505130	4250	4132	1988			4431	1990	4471	301	113			4980	5			295
114	45505141	4250	4113	1990	200	120	4431	1993	4471	301	113			4978	10			392
115	45505143	4250	4113	1990	200	120	4431	1993	4471	301	113			4978	10			283
116	45505154	4250	4113	1971			4431	1976	4471	301	113							250
117	51403037	4250	4113	1971			4431	1975	4473	200	107	4984						450
118	51803019	4250	4113	1977			4431	1978	4471	301	100							370
119	51804044	4250	4113	1989			4465	1989										
120	51804046	4250	4113	1968			4431	1991										414
121	51804047	4250	4113	1988			4431	1989	4471	301				4978	10			475
122	51804048	4981	4113	1989			4431	1990	4471	301				4978	6			364
123	51804050	4981	4113	1989			4431	1990	4471	301				4978	6			370
124	51805004	4250	4113	1973			4431	1975	4473	200	107	4984						720
125	51805005	4250	4113	1973			4431	1977	4471	301				4978	6			620
126	51805013	4250	4113	1988			4431	1990	4471	301				4978	10			487
127	51805015	4250	4131	1986			4451	1987	4491					4980	10			207
128	51805041	4981	4113	1989			4465	1989	4471	304								
129	51805057	4981	4113	1973			4431	1977	4471	301				4978	6			620
130	51805058	4250	4113	1973			4431	1977	4471	301				4978	6			620
131	51901103	4981	4133	1984			4451	1985	4493	200	107			4975	10			111
132	51901105	4981	4113	1984			4451	1985	4493	200	107			4975	10			111

133	61006001	4250	4132	1989	4451	1990	4493	200	107	4984	4975	10	226
134	61006046	4250	4132	1991	4451	1991	4493						200
135	61006056	4250	4132	1989	4451	1990	4493	200	107	4984	4975	10	226
136	61006080	4250	4132	1990	4451	1991	4493	200	107	4984	4975	10	200
137	61006085	4981	4113	1988	4451	1988	4493	200	107	4984	4975	11	411
138	61008032	4981	4113	1985	4431	1986	4473	200	107	4984	4975	10	550
139	61008057	4981	4114	1990	4431	1992	4471				4978	9	700

	stand #	F94	FT	S	AS	EL	HABT	ssc	scor	POS	Refor	Ref Yr	VRU	FIRE
1	10606021	4250	LP	17	NE	48	740	SAPL	1975		4451	1975	7N	Webb
2	10606027	4981	LP	18	N	54	625	SAPL	1975		4451	1975	7N	Webb
3	10606030	4981	LP	15	N	56	740	SAPL	1982		4451	1981	7N	Webb
4	10606031	4981	L	23	NE	53	732	SAPL	1981		4451	1981	7N	Webb
5	10606034	4981	L	31	NE	49	621	SAPL	1980		4451	1981	5N	Webb
6	10606110	4981	DF	15	E	52	620	SAPL	1981		4431	1981	7S	Webb
7	10702023	4250	L	16	E	47	323	SAPL	1981		4431	1981	2S	Webb
8	10702064	4981	L	21	E	47	323	SEED	1991		4451	1991	2S	Webb
9	10702066	4981	LP	17	E	46	292	SEED	1992		4431	1992	2S	Webb
10	10704023	4250	PP	28	S	41	731	SAPL	1980		4451	1979	2S	Webb
11	10704024	4250	PP	34	S	42	350	SEED	1980		4451	1979	2S	Webb
12	10704026	4981	L	23	SE	51	661	SAPL	1986		4431	1986	7S	Webb
13	10704027	4981	DF	22	S	49	620	SEED	1981		4431	1981	7S	Webb
14	10704028	4981	LP	19	SE	47	663	SAPL	1980		4451	1980	2S	Webb
15	10704030	4981	DF	30	SE	48	322	SAPL	1980		4451	1980	2S	Webb
16	10704034	4981	DF	26	E	49	521	SAPL	1981		4451	1980	7S	Webb
17	10704035	4981	LP	19	E	47	250	SAPL	1980		4451	1980	2S	Webb
18	10704036	4981	DF	16	SE	52	620	SAPL	1981		4431	1981	7S	Webb
19	10704048	4981	LP	20	SE	52	731	SAPL	1986		4431	1986	7S	Webb
20	10704078	4981	L	16	SE	53	312	SEED	1991		4451	1991	7S	Webb
21	10704080	4981	PP	26	SE	46	323	SEED	1992		4431	1992	2S	Webb
22	11104013	4981	L	22	NW	52	740	SEED	1989		4451	1989	7S	North Fork
23	11104018	4981	L	29	E	55	740	SAPL	1981		4451	1979	7S	North Fork
24	11104019	4981	SAF	33	S	58	670	SEED	1981		4451	1981	9	North Fork
25	11104024	4981	L	21	NE	46	531	POLE	1981		4451	1978	5S	North Fork
26	11104032	4981	SAF	30	E	58	670	SEED	1989		4451	1989	9	North Fork
27	11104033	4981	SAF	32	E	57	670	SEED	1989		4451	1989	9	North Fork
28	11104109	4981	LP	36	SE	57	740	SEED	1989		4451	1989	9	North Fork
29	11104111	4250	L	30	NW	49	350	NONS	1994				7N	North Fork
30	11202005	4981	SAF	29	W	54	740	NONS	1994		4451	1975	7S	North Fork
31	11202029	4250	L	30	SE	53	730	NONS	1994		4451	1989	7S	North Fork
32	11202030	4250	LP	33	W	55	624	SEED	1989		4451	1989	7S	North Fork
33	11202031	4250	LP	22	SW	51	624	NONS	1994		4451	1989	7S	North Fork

	stand #	F94	FT	S	AS	EL	HABT	ssc	scor	POS	Refor	Ref Yr	VRU	FIRE
34	11202032	4250	L	20	SW	47	620	SEED	1990		4451	1990	7S	North Fork
35	11202033	4250	L	52	SW	46	621	NONS	1994		4451	1989	2S	North Fork
36	11202034	4250	L	34	SE	46	531	NONS	1994		4451	1989	7S	North Fork
37	11202035	4250	L	36	SW	49	625	NONS	1994		4451	1989	7S	North Fork
38	11202036	4250	LP	21	SW	46	740	NONS	1994		4451	1989	7S	North Fork
39	11202037	4250	LP	30	S	58	624	NONS	1994		4451	1989	9	North Fork
40	11202038	4250	L	26	S	48	530	NONS	1994		4451	1990	7S	North Fork
41	11202039	4250	LP	49	NW	46	531	NONS	1994		4451	1989	7S	North Fork
42	11203001	4250	SAF	23	SW	59	740	NONS	1994		4451	1975	9	North Fork
43	11203002	4981	SAF	29	NW	52	571	SAPL	1983		4451	1975	7S	North Fork
44	11203003	4981	SAF	36	NW	56	571	SAPL	1979		4451	1976	7S	North Fork
45	11203004	4981	SAF	28	SW	58	740	SAPL	1985		4451	1975	7S	North Fork
46	11203005	4250	SAF	36	N	56	670	NONS	1994		4451	1974	7S	North Fork
47	11203059	4250	LP	29	W	49	570	SEED	1991		4451	1990	7S	North Fork
48	11203060	4250	L	47	SW	47	730	NONS	1994		4451	1989	7S	North Fork
49	11203061	4981	L	28	W	51	730	SEED	1990		4451	1990	7S	North Fork
50	11203065	4250	WP	40	S	53	670	NONS	1994		4451	1989	7S	North Fork
51	11203066	4250	DF	36	NW	53	531	NONS	1994		4451	1989	7S	North Fork
52	11203067	4981	LP	27	W	55	740	SEED	1989		4431	1988	7S	North Fork
53	11204001	4250	SAF	35	SW	56	740	NONS	1994		4451	1974	7S	North Fork
54	11204008	4981	L	21	NE	47	670	SAPL	1979		4431	1979	5N	North Fork
55	11204009	4981	SAF	30	NE	57	670	SAPL	1980		4451	1979	7N	North Fork
56	11204010	4981	SAF	31	E	53	740	SAPL	1979		4451	1977	7S	North Fork
57	11204011	4981	SAF	30	E	55	670	SAPL	1979		4451	1978	7S	North Fork
58	11204012	4981	LP	31	E	55	670	SAPL	1985		4451	1976	7S	North Fork
59	11204013	4981	SAF	25	E	55	740	SAPL	1984		4451	1977	7S	North Fork
60	11204105	4250	WP	39	NW	53	740	NONS	1994		4451	1989	7S	North Fork
61	11204107	4250	SAF	30	NW	52	670	NONS	1994		4451	1991	7S	North Fork
62	11204108	4250	L	31	NE	52	570	NONS	1994		4451	1988	7N	North Fork
63	11303025	4250	SAF	11	S	45	732	NONS	1994		4451	1980	7S	336
64	11303026	4250	LP	17	SW	48	570	NONS	1994		4431	1984	7S	336
65	11303027	4250	DF	18	SE	47	570	NONS	1994		4431	1984	7S	336
66	11304098	4981	DF	16	SE	47	570	NONS	1994		4431	1984	7S	336

	stand #	F94	FT	S	AS	EL	HABT	ssc	scor	POS	Refor	Ref Yr	VRU	FIRE
67	40504128	4250	SAF	16	E	61	620	SAPL	1968		4451	1977	7N	Thunder Hill
68	41208120	4250	L	30	W	45	571	SAPL	1965		4451	1977	5S	Burnt Sheep
69	42401115	4250	L	35	NE	35	310	SAPL	1974		4451	1974	5N	Zimm
70	42402103	4250	L	30	E	38	570	SAPL	1986		4451	1984	5N	Zimm
71	42402117	4250	L	30	NE	45	570	SAPL	1981		4451	1982	5N	Zimm
72	42402120	4250	WH	30	N	41	570	SAPL	1984		4431	1987	5N	Zimm
73	42503145	4250	LP	30	SW	46	620	SEED	1991		4451	1991	5S	Fish Fry
74	42504110	4250	LP	20	S	45	620	SEED	1991		4451	1991	5S	Fish Fry
75	42504115	4250	L	16	W	41	570	SEED	1991		4451	1991	5S	Fish Fry
76	42504136	4250	LP	30	SW	49	740	SEED	1992		4451	1992	5S	Fish Fry
77	42504144	4250	LP	30	SW	49	620	SEED	1991		4451	1993	5S	Fish Fry
78	42505114	4250	LP	30	S	49	571	SEED	1991		4451	1991	5S	Fish Fry
79	42701122	4250	LP	20	W	48	531	SAPL	1984		4465	1984	5S	Fowler
80	42701126	4250	L	40	SW	47	531	SAPL	1984		4451	1984	5S	Fowler
81	42701134	4250	LP	35	SW	52	620	SAPL	1984		4431	1990	7S	Fowler
82	42701136	4250	LP	35	SW	52	620	SAPL	1985		4451	1985	7S	Fowler
83	42701139	4250	LP	40	SW	53	690	SEED	1985		4451	1985	7S	Fowler
84	42701144	4250	LP	30	SW	53	531	SEED	1984		4451	1985	7S	Fowler
85	42701147	4250	DF	30	NW	49	570	SEED	1987		4451	1988	5S	Fowler
86	42701153	4250	SAF	40	N	53	692	SAPL	1986		4451	1986	7S	Fowler
87	42701154	4250	DF	45	W	52	690	SAPL	1989		4431	1990	7S	Fowler
88	42704119	4250	DF	25	W	50	570	SEED	1987		4451	1988	7S	Fowler
89	42704122	4250	LP	35	NE	46	571	NONS	1986		4451	1989	5N	Fowler
90	42704136	4250	SAF	30	W	54	692	SEED	1986		4451	1986	9	Fowler
91	42704140	4250	SAF	25	W	56	692	SAPL	1987		4431	1989	9	Fowler
92	42704141	4250	SAF	35	SW	56	692	NONS	1987		4451	1988	9	Fowler
93	42704171	4250	SAF	25	W	57	690	SAPL	1987		4431	1989	9	Fowler
94	42704172	4250	L	20	W	60	625	SAPL	1980		4451	1979	9	Fowler
95	42704178	4981	LP	30	W	57	670	SAPL	1986		4451	1986	7S	Fowler
96	42803112	4250	DF	35	S	50	320	SAPL	1983		4431	1983	5S	Pink Mtn
97	44406146	4250	WH	25	E	46	570	SAPL	1987		4431	1987	5N	Will Do
98	44501242	4250	WH	50	E	52	620	SAPL	1987		4431	1985	7S	Roberts
99	45102166	4250	DF	45	S	45	690	SAPL	1988		4431	1988	4S	Gunsight

	stand #	F94	FT	S	AS	EL	HABT	ssc	scor	POS	Refor	Ref Yr	VRU	FIRE
100	45302121	4250	WH	40	NW	38	570	SAPL	1983		4431	1983	5S	Studebaker
101	45402175	4250	SAF	50	W	52	620	POLE	1948		4431	1969	7S	Pulpit Mtn
102	45404122	4250	DF	50	W	46	620	SAPL	1960		4431	1981	5S	Pulpit Mtn
103	45404123	4250	DF	50	SW	47	620	SAPL	1961		4432	1983	7S	Pulpit Mtn
104	45404142	4250	PP	50	W	44	260	SAPL	1964		4431	1983	5S	Pulpit Mtn
105	45404146	4250	SAF	30	W	46	570	SAPL	1961		4432	1981	5N	Pulpit Mtn
106	45504105	4250	LP	40	S	46	570	SEED	1990		4451	1990	5S	China Basin
107	45504114	4250	DF	30	SE	39	260	NONS	1994		4431	1992	5S	China Basin
108	45505118	4250	DF	35	SE	50	260	NONS	1994		4431	1994	7S	China Basin
109	45505122	4250	LP	40	S	46	570	NONS	1994		4451	1990	5S	China Basin
110	45505125	4250	L	30	SE	39	570	NONS	1994		4431	1992	5S	China Basin
111	45505127	4250	DF	50	S	42	260	NONS	1994		4431	1991	5S	China Basin
112	45505129	4250	LP	45	S	48	624	NONS	1994		4431	1990	7S	China Basin
113	45505130	4250	LP	40	S	50	624	NONS	1994		4431	1990	7S	China Basin
114	45505141	4250	GF	60	SE	42	570	NONS	1994		4431	1993	5S	China Basin
115	45505143	4250	GF	50	W	45	570	NONS	1994		4431	1993	5S	China Basin
116	45505154	4250	L	60	NW	48	620	NONS	1994		4431	1976	7N	China Basin
117	51403037	4250	DF	30	SE	37	322	SAPL	1975		4431	1975	5S	10 Pipe Ridge
118	51803019	4250	L	45	SE	47	355	SAPL	1978		4431	1978	5S	Quartz #3
119	51804044	4250	L	60	NE	31	357	SEED	1995		4465	1989	5N	China Basin
120	51804046	4250	L	60	NE	37	357	SEED	1995		4431	1991	5N	China Basin
121	51804047	4250	L	60	NE	39	406	SEED	1995		4431	1989	5N	China Basin
122	51804048	4981	L	70	NE	38	403	SEED	1990		4431	1990	5N	China Basin
123	51804050	4981	L	60	NE	38	357	SEED	1990		4431	1990	5N	China Basin
124	51805004	4250	DF	30	E	49	355	SEED	1995		4431	1975	4N	China Basin
125	51805005	4250	DF	52	NW	42	357	SEED	1995		4431	1977	5N	China Basin
126	51805013	4250	L	50	NE	38	355	SEED	1995		4431	1990	5N	China Basin
127	51805015	4250	L	42	E	43	355	SEED	1995		4451	1987	4N	China Basin
128	51805041	4981	L	60	N	33	355	SEED	1995		4465	1989	5N	China Basin
129	51805057	4981	DF	52	NW	42	357	SEED	1995		4431	1977	5N	China Basin
130	51805058	4250	DF	52	NW	47	357	SEED	1995		4431	1977	5N	China Basin
131	51901103	4981	DF	25	SE	48	355	SAPL	1985		4451	1985	2S	China Basin
132	51901105	4981	DF	25	SE	48	355	NONS	1994		4451	1985	2S	China Basin

	stand #	F94	FT	S	AS	EL	HABT	ssc	scor	POS	Refor	Ref Yr	VRU	FIRE
133	61006001	4250	L	30	W	44	352	SEED	1994		4451	1990	3	Cripple Horse
134	61006046	4250	DF	30	SW	40	355	SEED	1991		4451	1991	3	Cripple Horse
135	61006056	4250	DF	30	W	44	355	SEED	1995		4451	1990	3	Cripple Horse
136	61006080	4250	L	40	SW	44	352	SEED	1995		4451	1991	3	Cripple Horse
137	61006085	4981	LP	40	SW	42	352	SEED	1988		4451	1988	9	Cripple Horse
138	61008032	4981	L	30	NE	42	352	SAPL	1986		4431	1986	7N	Cripple Horse
139	61008057	4981	L	30	NE	46	355	SEED	1992		4431	1992	7N	Cripple Horse

APPENDIX B

FREQUENCY DISTRIBUTION OF

INDEPENDENT VARIABLES

Table 1. Frequency distribution of fire codes by stand slope.

SLOPE (%)	REGEN LOSS (4250)	NO REGEN LOSS (4981)	Total
11	1		1
15		2	2
16	3	3	6
17	2	1	3
18	1	1	2
19		2	2
20	4	1	5
21	1	3	4
22	1	2	3
23	1	2	3
25	4	3	7
26	1	2	3
27		1	1
28	1	2	3
29	1	3	4
30	23	7	30
31	1	3	4
32		1	1
33	1	1	2
34	2		2
35	8		8
36	3	2	5
39	1		1
40	9	1	10
42	1		1
45	4		4
47	1		1
49	1		1
50	8		8
52	3	1	4
60	5	2	7
70		1	1
Total	**92**	**47**	**139**

Figure 1. Frequency distribution of fire codes by stand slope.

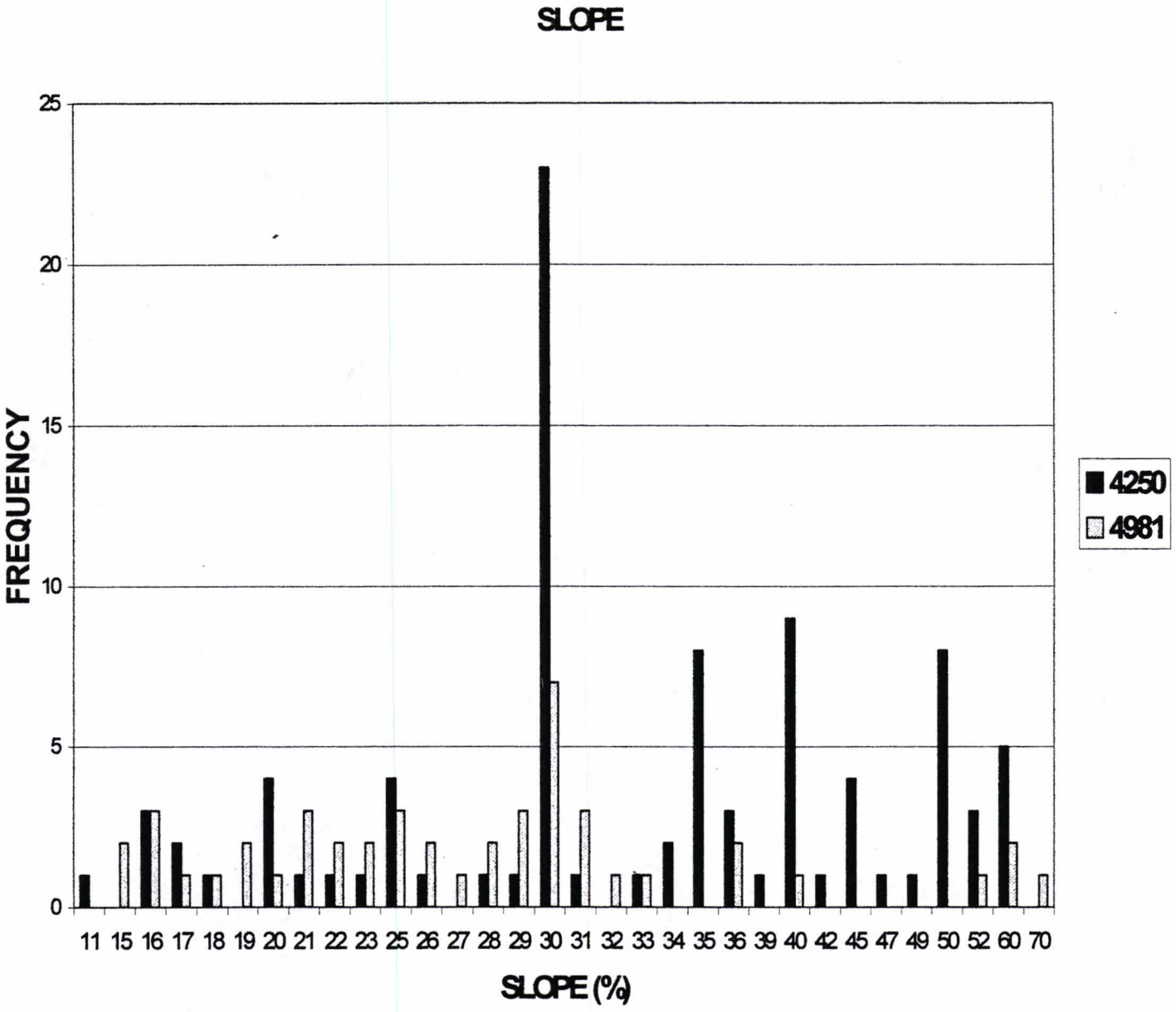

Table 2a. Frequency distribution of fire codes by stand aspect class. Number in parenthesis is the row percent.

ASPECT	REGEN LOSS (4250)	NO REGEN LOSS (4981)	Total
E	7(37)	12(63)	19(100)
N	3(50)	3(50)	6(100)
NE	9(50)	9(50)	18(100)
NW	10(71)	4(29)	14(100)
S	15(88)	2(12)	17(100)
SE	9(45)	11(55)	20(100)
SW	21(91)	2(8)	23(100)
W	18(82)	4(18)	22(100)
Total	**92(66)**	**47(34)**	**139(100)**

Table 2b. Frequency distribution of fire codes by stand aspect class. Number in parenthesis is the column percent.

ASPECT	REGEN LOSS (4250)	NO REGEN LOSS (4981)	Total
E	7(8)	12(26)	19(14)
N	3(3)	3(6)	6(4)
NE	9(10)	9(19)	18(13)
NW	10(11)	4(9)	14(10)
S	15(16)	2(4)	17(12)
SE	9(9)	11(23)	20(14)
SW	21(23)	2(4)	23(17)
W	18(20)	4(9)	22(16)
Total	**92(100)**	**47(100)**	**139(100)**

Figure 2. Frequency distribution of fire codes by stand aspect class.

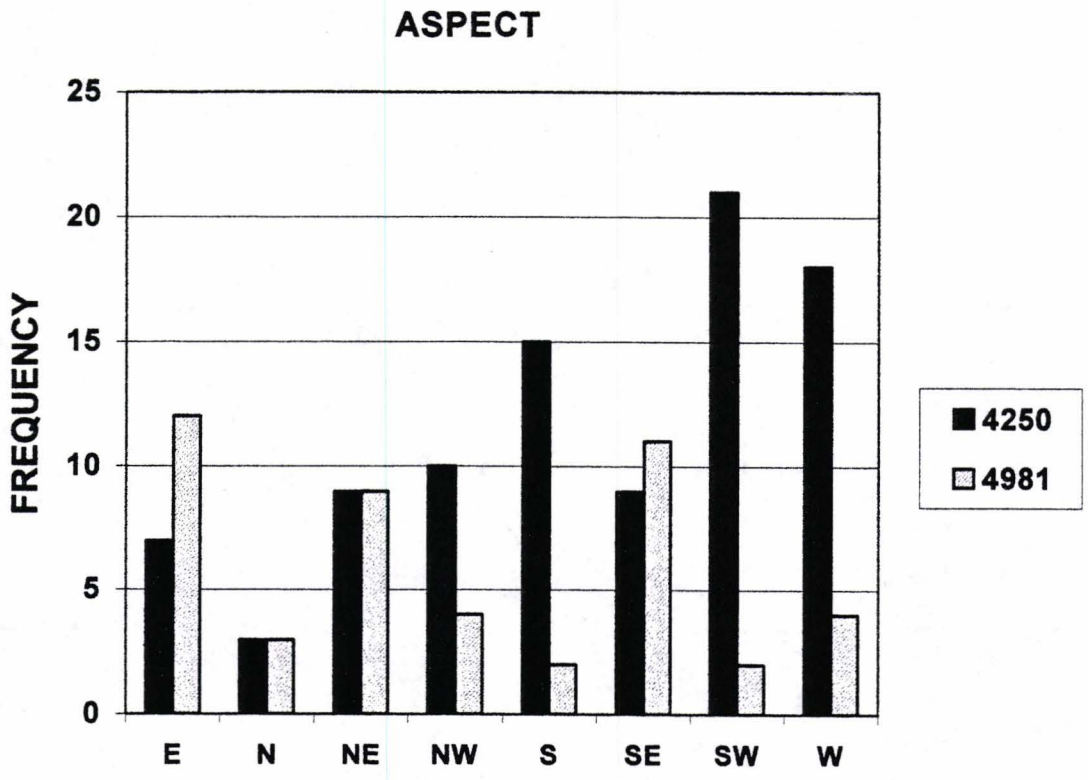

Table 3. Frequency distribution of fire codes by elevation class.

ELEVATION	REGEN LOSS (4250)	NO REGEN LOSS (4981)	Total
31	1		1
33		1	1
35	1		1
37	2		2
38	3	2	5
39	3		3
40	1		1
41	3		3
42	4	3	7
43	1		1
44	4		4
45	6		6
46	11	4	15
47	8	5	13
48	6	3	9
49	8	3	11
50	4		4
51	1	2	3
52	7	5	12
53	7	3	10
54	1	2	3
55	1	5	6
56	4	2	6
57	1	4	5
58	1	3	4
59	1		1
60	1		1
61	1		1
Total	**92**	**47**	**139**

Figure 3. Frequency of fire code by elevation. Curves are polynomials to indicate trends.

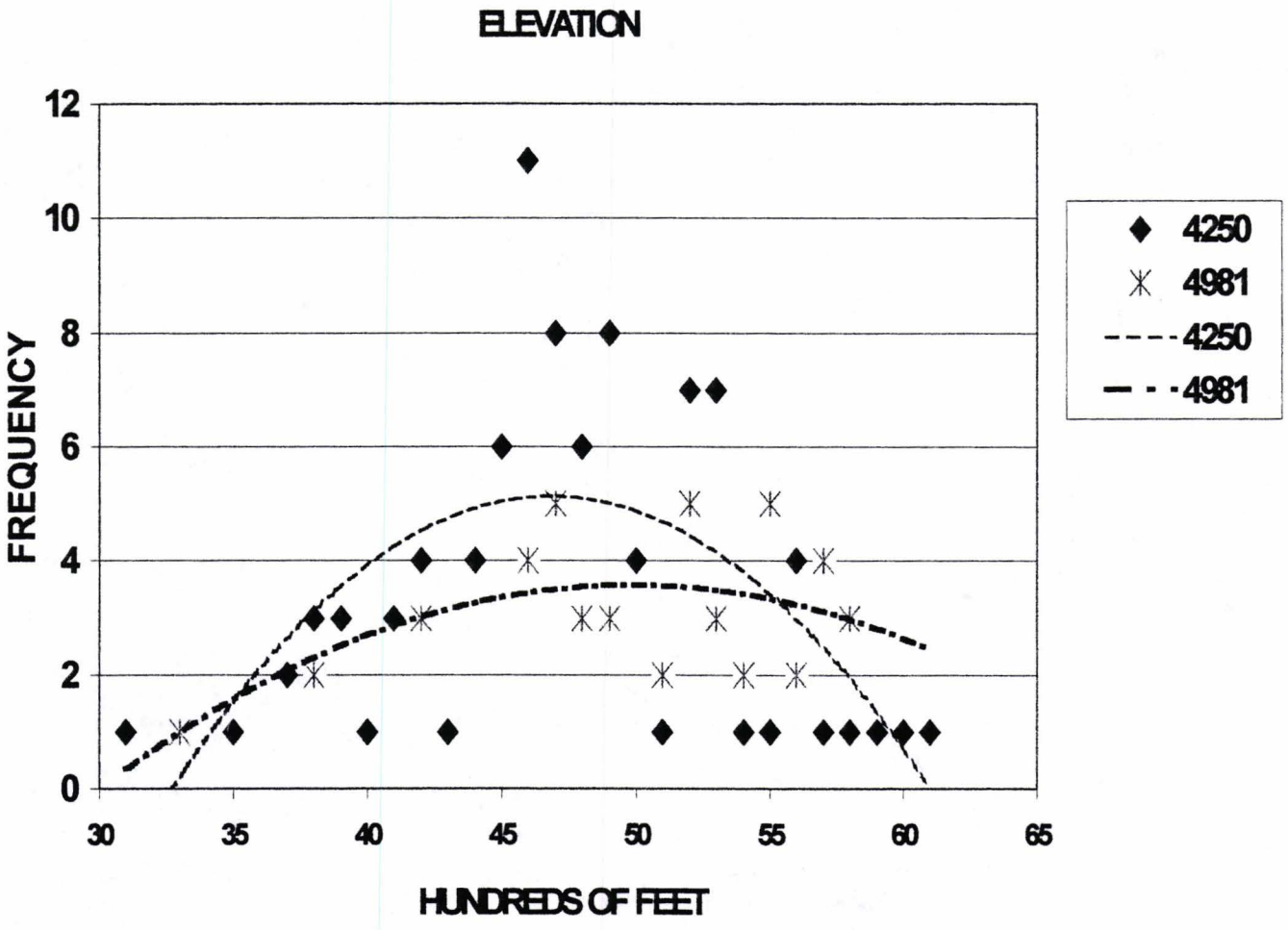

Table 4a. Frequency distribution of fire codes by habitat type group. Number in parenthesis is row percent.

HABITAT TYPE GROUPS	REGEN LOSS (4250)	NO REGEN LOSS (4981)	TOTAL
DF	22(61)	14(39)	36(100)
SP	1(50)	1(50)	2(100)
GF	0(0)	1(100)	1(100)
WRC	7(88)	1(12)	8(100)
WH	21(88)	3(12)	24(100)
SAF	41(60)	27(40)	68(100)
TOTAL	**92(66)**	**47(34)**	**139(100)**

Table 4b. Frequency distribution of fire codes by habitat type group. Number in parenthesis is column percent.

HABITAT TYPE GROUPS	REGEN LOSS (4250)	NO REGEN LOSS (4981)	TOTAL
DF	22(24)	14(30)	36(26)
SP	1(1)	1(2)	2(1)
GF	0(0)	1(2)	1(<1)
WRC	7(8)	1(2)	8(6)
WH	21(23)	3(6)	24(17)
SAF	41(45)	27(57)	68(49)
TOTAL	**92(100)**	**47(100)**	**139(100)**

Figure 4. Frequency distribution of fire codes by habitat type group.

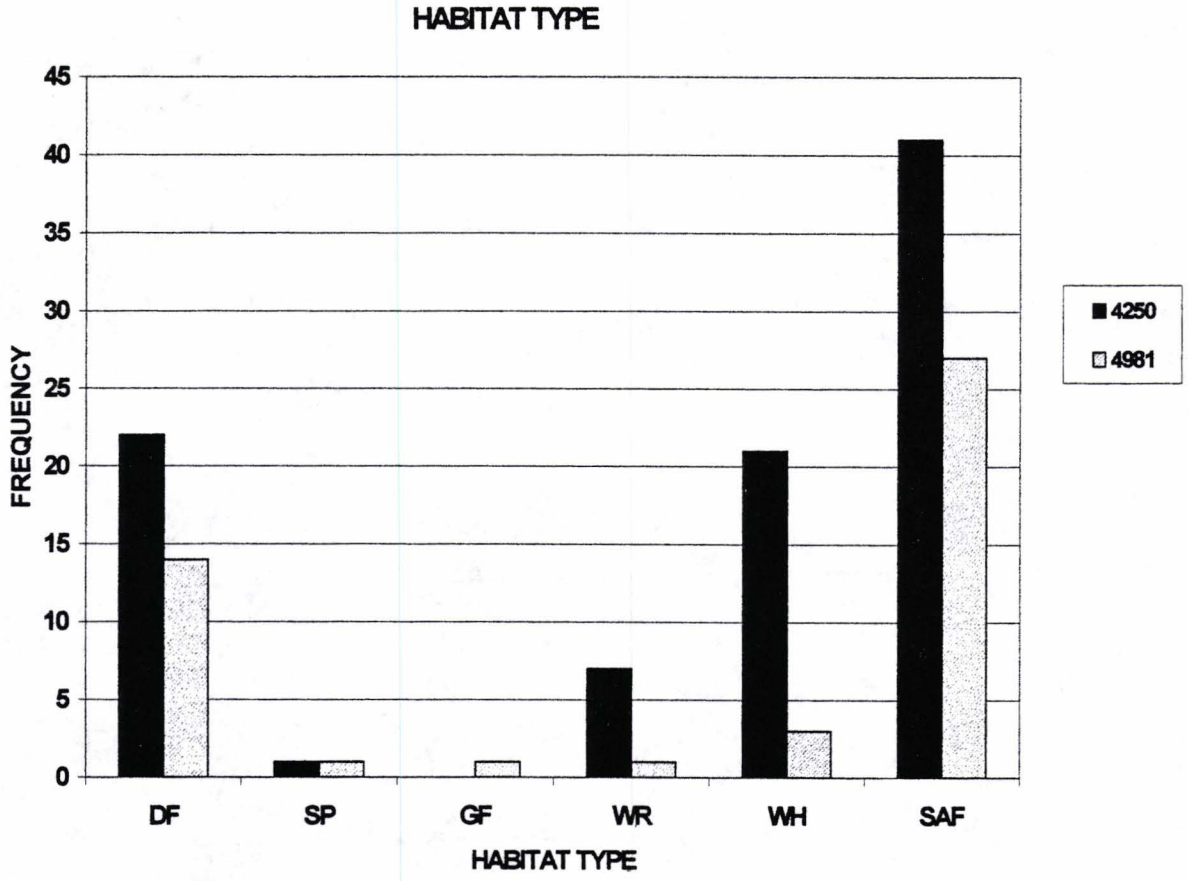

Table 5a. Frequency distribution of fire codes by stand size class. Number in parenthesis is row percent.

STAND SIZE CLASS	REGEN LOSS (4250)	NO REGEN LOSS (4981)	Total
NONSTOCKED	34(92)	3(8)	37(100)
POLE	1(50)	1(50)	2(100)
SAPLING	29((54)	25(46)	54(100)
SEED	28(61)	1839)	46(100)
Total	**92(66)**	**47(34)**	**139(100)**

Table 5b. Frequency distribution of fire codes by stand size class. Number in parenthesis is column percent.

STAND SIZE CLASS	REGEN LOSS (4250)	NO REGEN LOSS (4981)	Total
NONSTOCKED	34(37)	3(6)	37(27)
POLE	1(1)	1(2)	2(1)
SAPL	29(32)	25(53)	54(39)
SEED	28(30)	18(38)	46(33)
Total	**92(100)**	**47(100)**	**139(100)**

Figure 5. Frequency distribution of fire codes by stand size class.

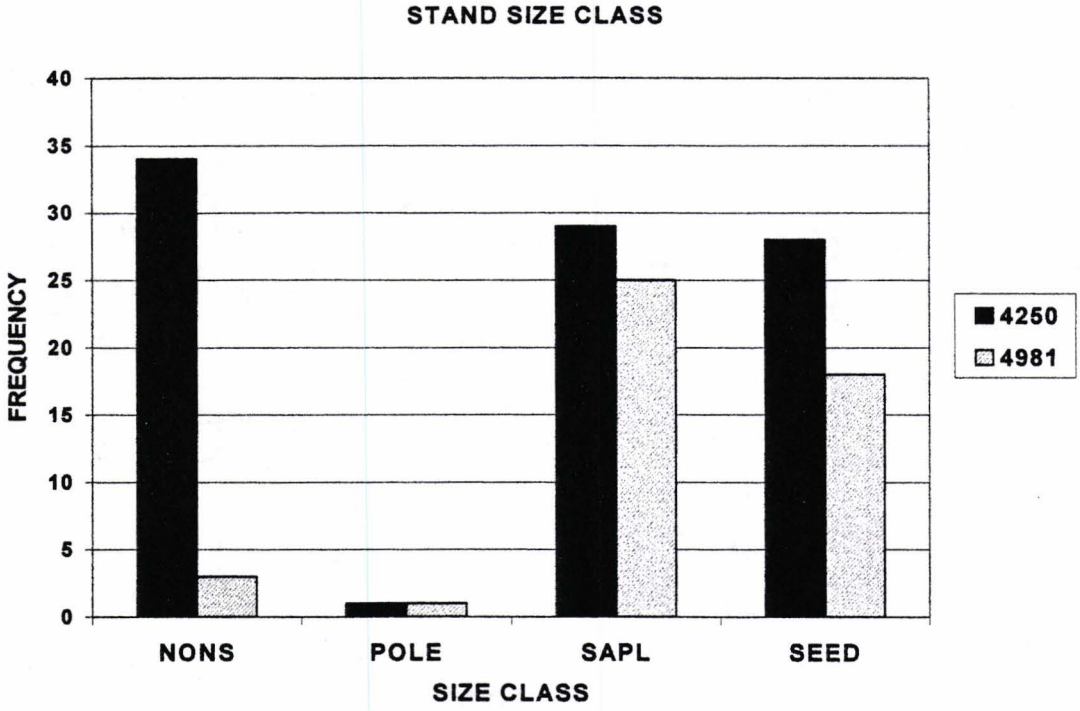

Table 6a. Frequency distribution of fire codes by TPA class. Number in parenthesis is the row percent.

TPA CLASS	REGEN LOSS (4250)	NO REGEN LOSS (4981)	TOTAL
<500 TPA	65(78)	18(22)	83(100)
500≤ TPA <1000	23(51)	22(49)	45(100)
1000≤ TPA <4000	1(14)	6(86)	7(100)
TOTAL	**89(66)**	**46(34)**	**135(100)**

Table 6b. Frequency distribution of fire codes by TPA class. Number in parenthesis is the column percent.

TPA	REGEN LOSS (4250)	NO REGEN LOSS (4981)	TOTAL
<500 TPA	65(73)	18(39)	83(61)
500≤ TPA <1000	23(26)	22(48)	45(33)
1000≤ TPA <4000	1(1)	6(13)	7(5)
TOTAL	**89(100)**	**46(100)**	**135(100)**

Figure 6. Frequency distribution of fire codes by TPA class.

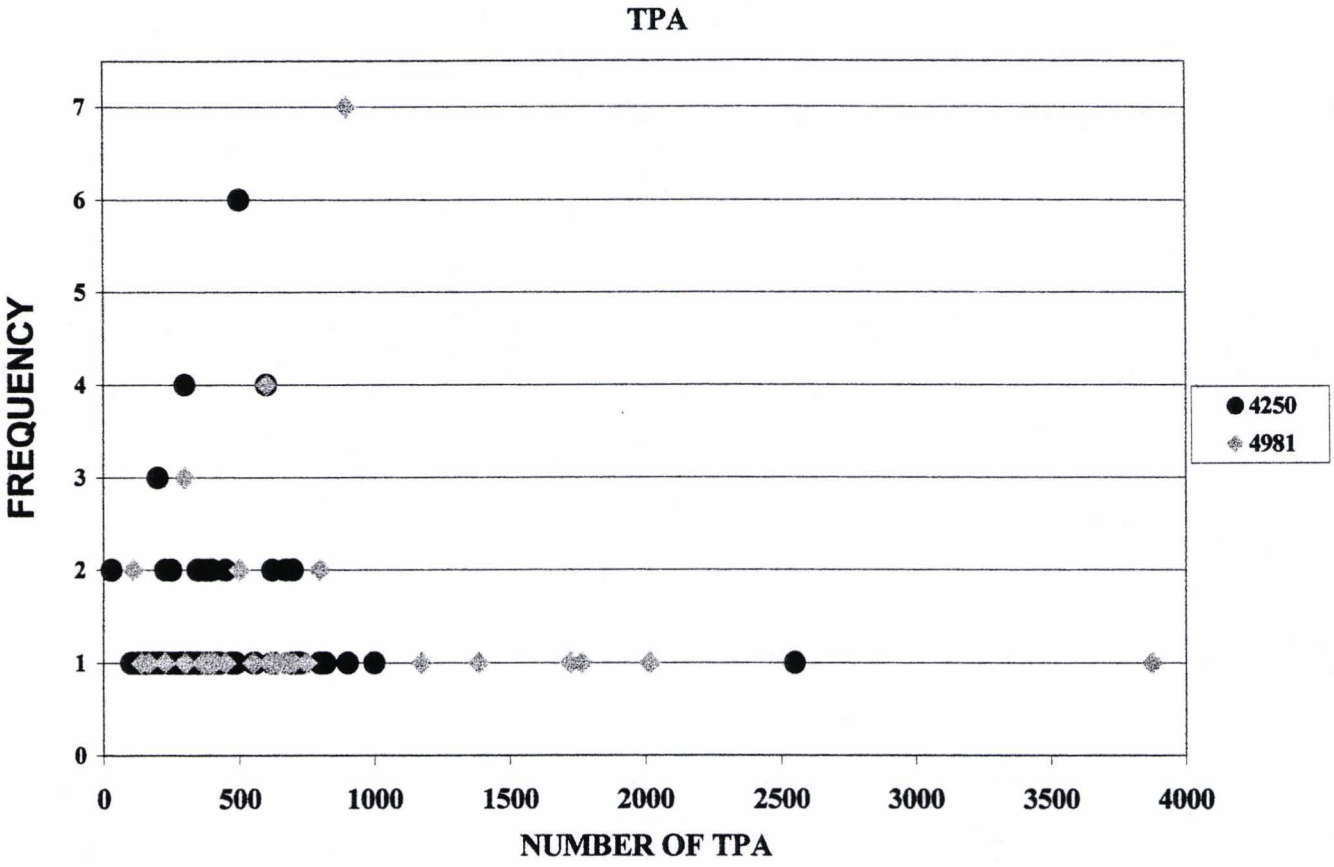

Table 7a. Frequency distribution of fire codes by forest type. Number in parenthesis is the row percent.

FOREST TYPE	REGEN LOSS (4250)	NO REGEN LOSS (4981)	Total
DF	18(67)	9(33)	27(100)
GF	2(100)	0(0)	2(100)
L	27(64)	15(36)	42(100)
LP	23(68)	11(32)	34(100)
PP	3(75)	1(25)	4(100)
SAF	13(54)	11(46)	24(100)
WH	4(100)	0(0)	4(100)
WP	2(100)	0(0)	2(100)
Total	**92(66)**	**47(34)**	**139(100)**

Table 7b. Frequency distribution of fire codes by forest type. Number in parenthesis is the column percent.

FOREST TYPE	REGEN LOSS (4250)	NO REGEN LOSS (4981)	Total
DF	18(20)	9(19)	27(19)
GF	2(2)	0(0)	2(1)
L	27(29)	15(32)	42(30)
LP	23(25)	11(23)	34(25)
PP	3(3)	1(2)	4(3)
SAF	13(14)	11(23)	24(17)
WH	4(4)	0(0)	4(3)
WP	2(2)	0(0)	2(1)
Total	**92(100)**	**47(100)**	**139(100)**

Figure 7. Frequency distribution of fire codes by forest type.

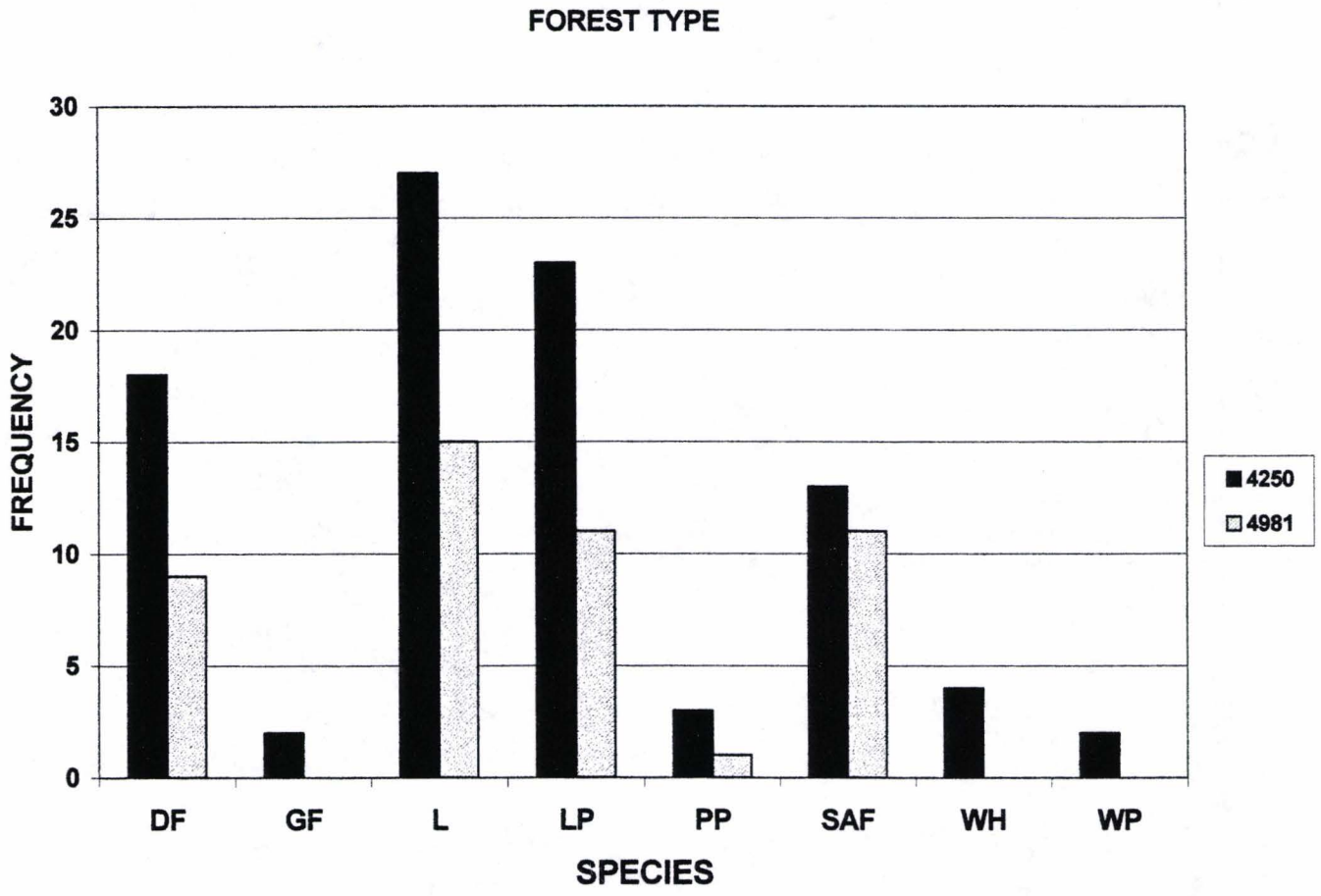

Table 8a. Frequency distribution of fire codes by vegetative response unit. Number in parenthesis is the row percent.

CODE	VEGETATIVE RESPONSE UNIT	REGEN LOSS (4250)	NO REGEN LOSS (4981)	Total
2S	MODERATELY WARM AND DRY (SOUTH)	4(33)	8(67)	12(100)
3	MODERATELY WARM AND MODERATELY DRY	4(80)	1(20)	5(100)
4N	MODERATELY WARM AND MOIST (NORTH)	2(100)	0(0)	2(100)
4S	MODERATELY WARM AND MOIST (SOUTH)	1(100)	0(0)	1(100)
5N	MODERATELY COOL AND MOIST (NORTH)	13(68)	6(32)	19(100)
5S	MODERATELY COOL AND MOIST (SOUTH)	23(96)	1(4)	24(100)
7N	COOL AND MOIST (NORTH)	5(46)	6(54)	11(100)
7S	COOL AND MOIST (SOUTH)	33(61)	21(39)	54(100)
9	COOL AND MODERATELY DRY	7(66)	4(34)	11(100)
Total		**92(66)**	**47(34)**	**139(100)**

Table 8b. Frequency distribution of fire codes by vegetative response unit. Number in parenthesis is the column percent.

CODE	VEGETATIVE RESPONSE UNIT	REGEN LOSS (4250)	NO REGEN LOSS (4981)	Total
2S	MODERATELY WARM AND DRY (SOUTH)	4(4)	8(17)	12(9)
3	MODERATELY WARM AND MODERATELY DRY	4(4)	1(2)	5(4)
4N	MODERATELY WARM AND MOIST (NORTH)	2(2)	0(0)	2(1)
4S	MODERATELY WARM AND MOIST (SOUTH)	1(1)	0(0)	1(1)
5N	MODERATELY COOL AND MOIST (NORTH)	13(14)	6(13)	19(14)
5S	MODERATELY COOL AND MOIST (SOUTH)	23(25)	1(2)	24(17)
7N	COOL AND MOIST (NORTH)	5(5)	6(13)	11(8)
7S	COOL AND MOIST (SOUTH)	33(36)	21(45)	54(39)
9	COOL AND MODERATELY DRY	7(8)	4(9)	11(8)
Total		**92(100)**	**47(100)**	**139(100)**

Figure 8. Frequency distribution of fire codes by vegetative response unit.

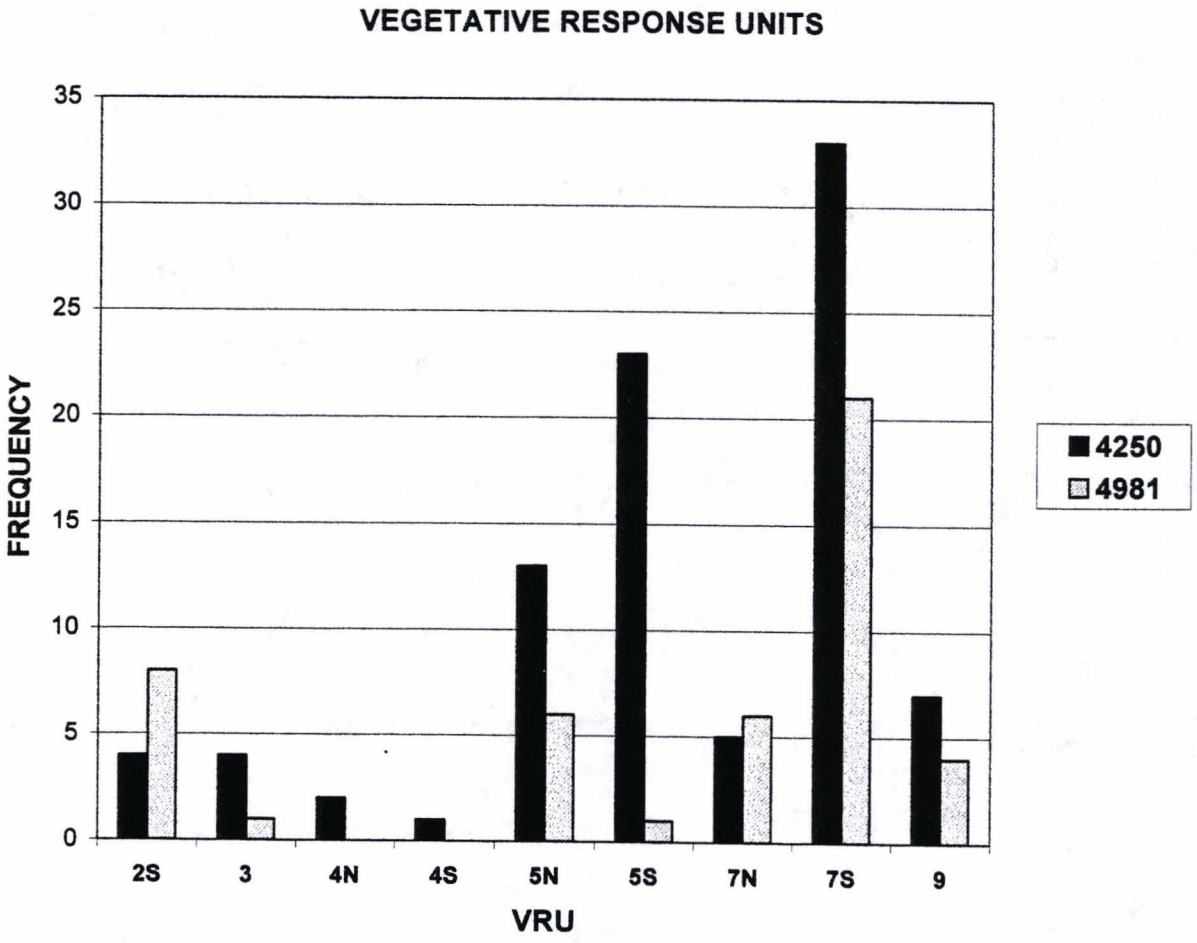

Table 9a. Frequency distribution of fire codes by harvest method. Number in parenthesis is the row percent.

CODE	HARVEST	REGEN LOSS (4250)	NO REGEN LOSS (4981)	Total
4111	CLEARCUT PATCH	3(38)	5(63)	8(100)
4113	CLEARCUT STAND	43(69)	19(31)	62(100)
4114	CLEARCUT W/RESERVES	0(0)	2(100)	2(100)
4132	SEED TREE SEED CUT	27(29)	15(36)	42(100)
4149	SEED TREE FINAL CUT W/RESERVES	1(100)	0(0)	1(100)
4131	SHELTERWOOD SEED CUT	17(77)	5(23)	22(100)
4133	SHELTERWOOD SEED CUT W/RESERVES	0(0)	1(100)	1(100)
4141	SHELTERWOOD REMOVAL CUT	1(100)	0(0)	1(100)
Total		**92(66)**	**47(34)**	**139(100)**

Table 9b. Frequency distribution of fire codes by harvest method. Number in parenthesis is the column percent.

CODE	HARVEST	REGEN LOSS (4250)	NO REGEN LOSS (4981)	Total
4111	CLEARCUT PATCH	3(3)	5(11)	8(6)
4113	CLEARCUT STAND	43(47)	19(40)	62(45)
4114	CLEARCUT W/RESERVES	0(0)	2(4)	2(1)
4132	SEED TREE SEED CUT	27(29)	15(32)	42(30)
4149	SEED TREE FINAL CUT W/RESERVES	1(1)	0(0)	1(1)
4131	SHELTERWOOD SEED CUT	17(19)	5(11)	22(16)
4133	SHELTERWOOD SEED CUT W/RESERVES	0(0)	1(2)	1(1)
4141	SHELTERWOOD REMOVAL CUT	1(1)	0(0)	1(1)
Total		**92(100)**	**47(100)**	**139(100)**

Figure 9. Frequency distribution of fire codes by harvest method.

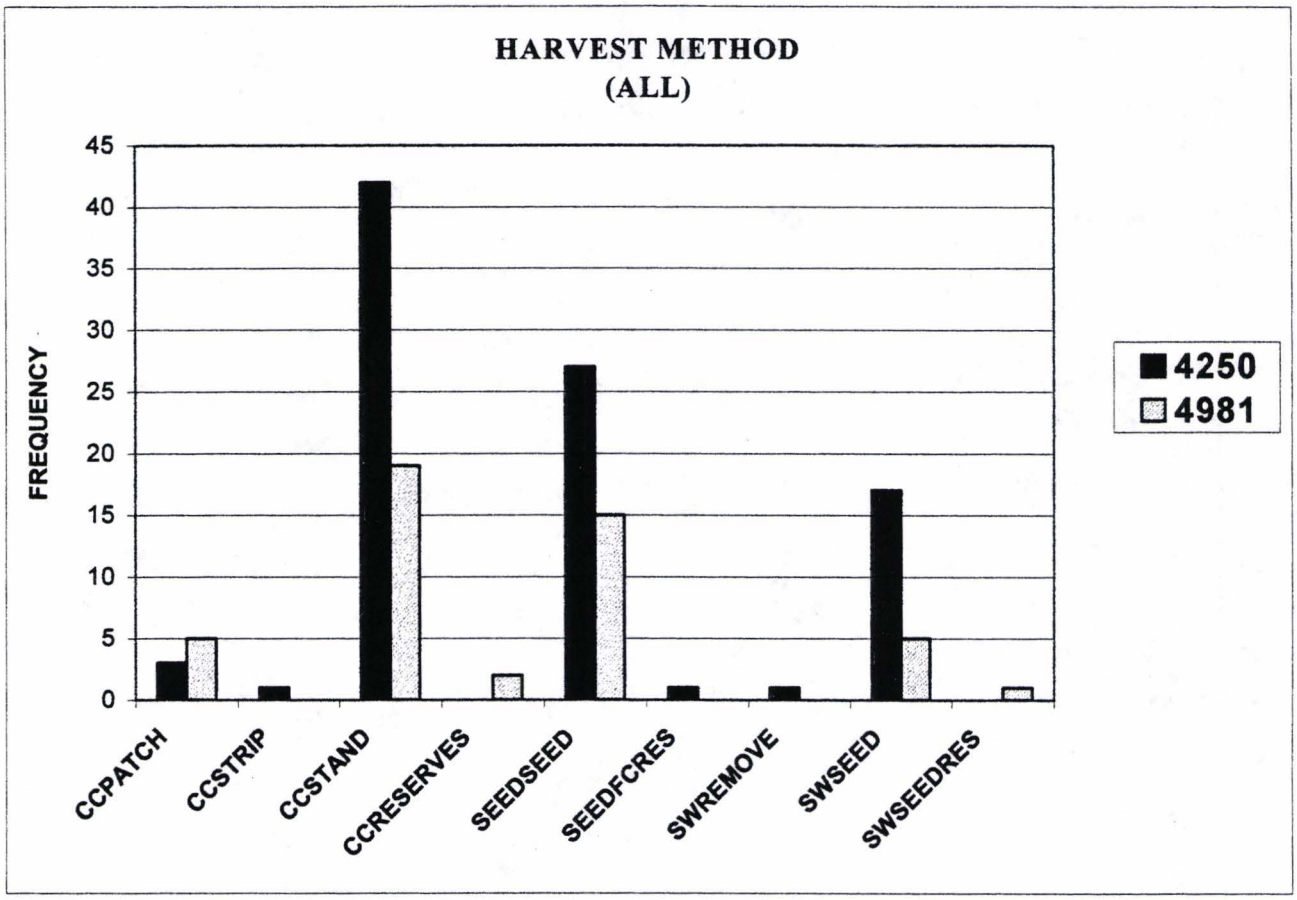

Table 10a. Frequency distribution of fire codes by harvest method grouped. Number in parenthesis is the row percent

HARVEST GROUPED	REGEN LOSS (4250)	NO REGEN LOSS (4981)	TOTAL
CLEARCUT	46(64)	26(36)	72(100)
SEED TREE	28(65)	15(35)	43(100)
SHELTER WOOD	18(75)	6(25)	24(100)
TOTAL	**92(66)**	**47(34)**	**139(100)**

Table 10b. Frequency distribution of fire codes by harvest method grouped. Number in parenthesis is the column percent.

HARVEST GROUPED	REGEN LOSS (4250)	NO REGEN LOSS (4981)	TOTAL
CLEARCUT	46(50)	26(55)	72(52)
SEED TREE	28(30)	15(32)	43(31)
SHELTERWOOD	18(20)	6(13)	24(17)
TOTAL	**92(100)**	**47(100)**	**139(100)**

Figure 10. Frequency distribution of fire codes by harvest method grouped.

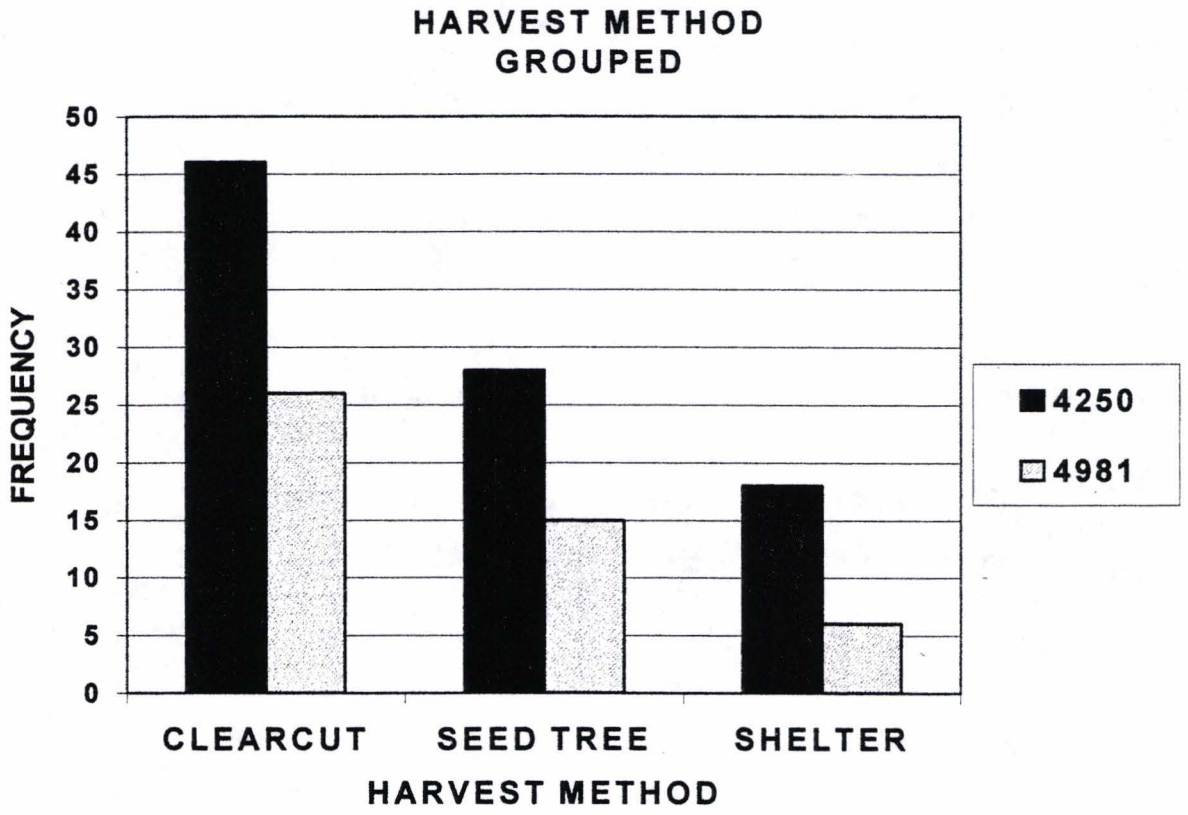

Table 11a. Frequency distribution of fire codes by harvest year grouped. Number in parenthesis is the row percent.

HARVEST YEAR GROUPED	REGEN LOSS (4250)	NO REGEN LOSS (4981)	TOTAL
1969-1979	23(58)	17(42)	40(100)
1980-1988	42(71)	17(29)	59(100)
1989-1993	27(68)	13(33)	40(100)
TOTAL	**92(66)**	**47(34)**	**139(100)**

Table 11b. Frequency distribution of fire codes by harvest year grouped. Number in parenthesis is the column percent.

HARVEST YEAR GROUPED	REGEN LOSS (4250)	NO REGEN LOSS (4981)	TOTAL
1969-1979	23(25)	17(36)	40(29)
1980-1988	42(46)	17(36)	59(42)
1989-1993	27(29)	13(28)	40(29)
TOTAL	**92(100)**	**47(100)**	**139(100)**

Figure 11. Frequency distribution of fire codes by harvest year.

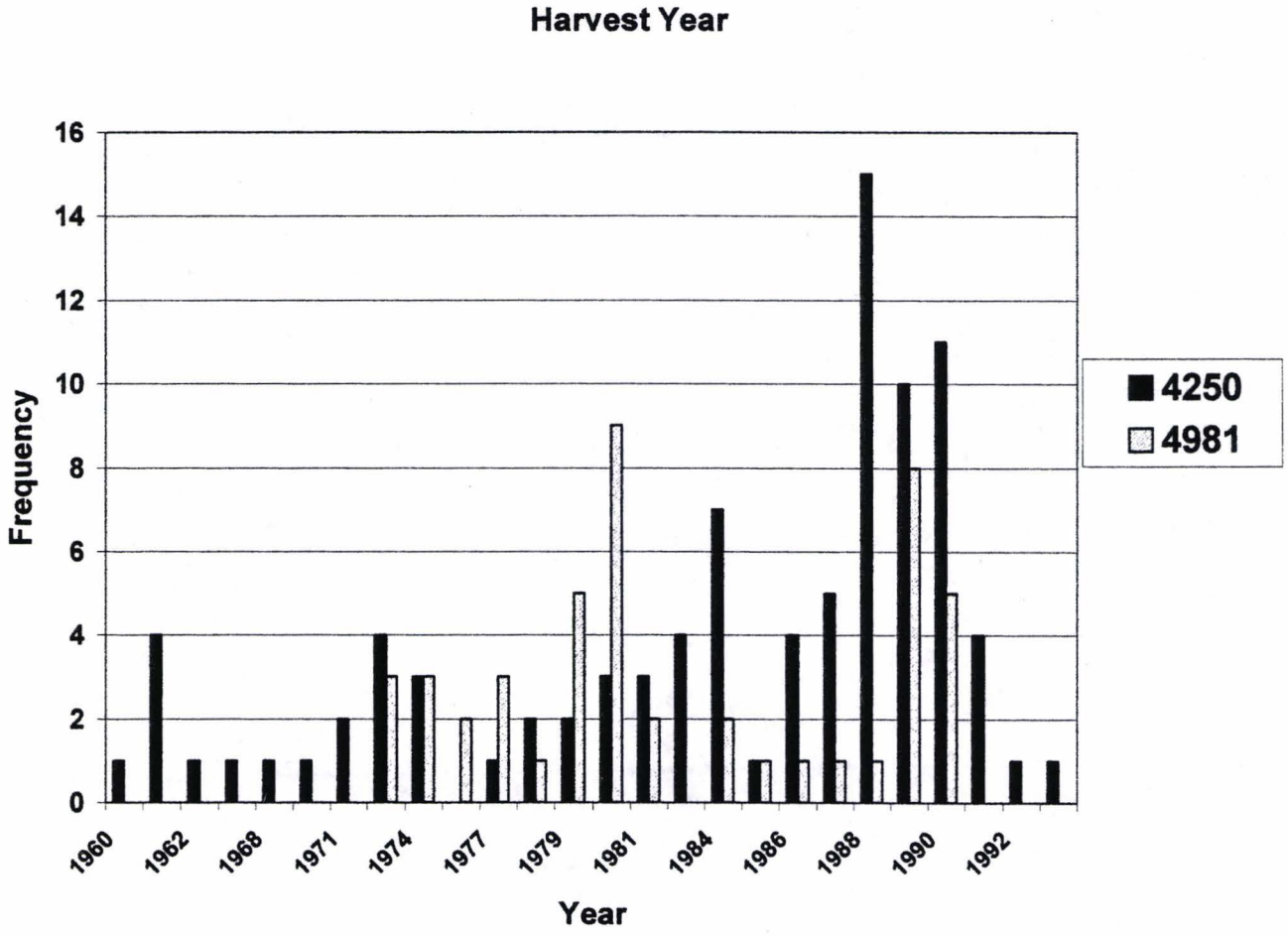

Table 12a. Frequency distribution of fire codes by regeneration method. Number in parenthesis is row percent.

CODE	REFORESTATION METHOD	REGEN LOSS (4250)	NO REGEN LOSS (4981)	Total
4431	PLANT	33(69)	15(31)	48(100)
4432	REPLANT	2(100)	0(0)	2(100)
4451	NATURAL	54(64)	31(66)	85(100)
4465	SLASHING	2(67)	1(33)	3(100)
Total		**91(66)**	**47(34)**	**138(100)**

Table 12b. Frequency distribution of fire codes by regeneration method. Number in parenthesis is the column percent.

CODE	REFORESTATION	REGEN LOSS (4250)	NO REGEN LOSS (4981)	Total
4431	PLANT	33(36)	15(32)	48(35)
4432	REPLANT	2(2)	0(0)	2(1)
4451	NATURAL	54(59)	31(66)	85(62)
4465	SLASHING	2(2)	1(2)	3(2)
Total		**91(100)**	**47(100)**	**138(100)**

Figure 12. Frequency distribution of fire codes by regeneration method.

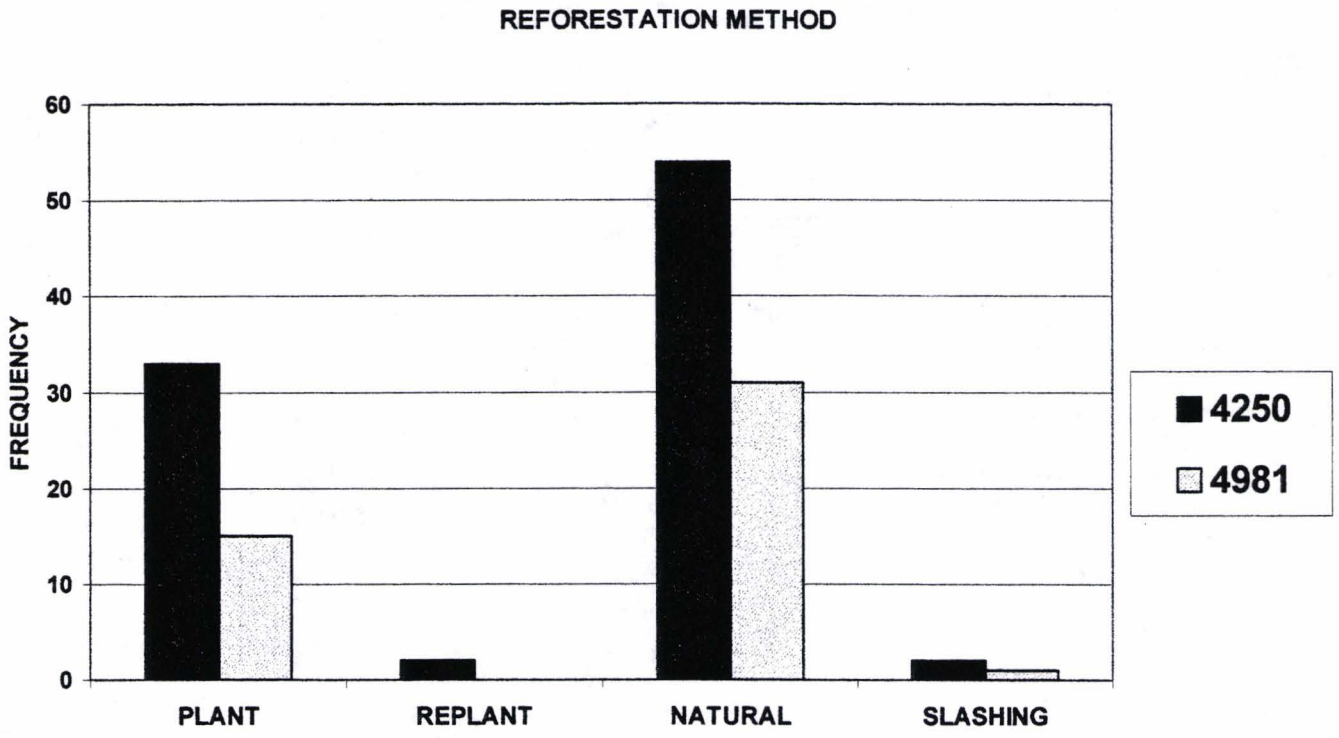

Table 13a. Frequency distribution of fire codes by reforestation year grouped. Number in parenthesis is the row percent.

REFORESTATION YEAR GROUPED	REGEN LOSS (4250)	NO REGEN LOSS (4981)	TOTAL
1974-1979	16(53)	14(47)	30(100)
1980-1984	14(54)	12(26)	26(100)
1985-1989	32(71)	13(29)	45(100)
1990-1994	29(78)	8(22)	37(100)
TOTAL	**91(66)**	**47(34)**	**138(100)**

Table 13b. Frequency distribution of fire codes by reforestation year grouped. Number in parenthesis is the column percent.

REFORESTATION YEAR GROUPED	REGEN LOSS (4250)	NO REGEN LOSS (4981)	TOTAL
1974-1979	16(18)	14(30)	30(22)
1980-1984	14(15)	12(26)	26(19)
1985-1989	32(35)	13(28)	45(33)
1990-1994	29(32)	8(17)	37(27)
TOTAL	**91(100)**	**47(100)**	**138(100)**

Figure 13. Frequency distribution of fire codes by reforestation year grouped.

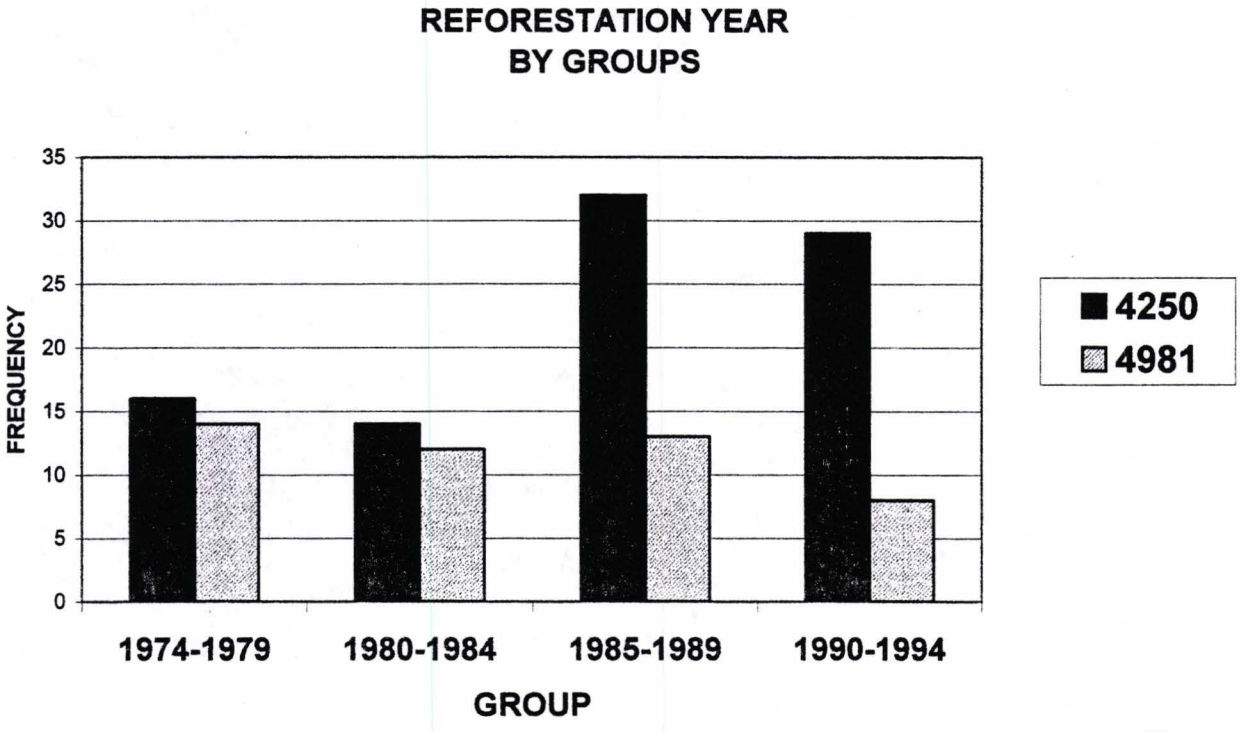

Table 14a. Frequency distribution of fire codes by site preparation type. Number in parenthesis is the row percent.

CODE	SITE PREPARATION TYPE	REGEN LOSS (4250)	NO REGEN LOSS (4981)	Total
4471	BURNING FOR PLANTING	24(67)	12(33)	36(100)
4473	MECHANICAL FOR PLANTING	7(70)	3(30)	10(100)
4491	BURNING FOR NATURAL REGENERATION	29(70)	12(29)	41(100)
4493	MECHANICAL FOR NATURAL REGENERATION	21(51)	20(49)	41(100)
Total		**81(63)**	**47(37)**	**128(100)**

Table 14b. Frequency distribution of fire codes by site preparation type. Number in parenthesis is the column percent.

CODE	SITE PREPARATION TYPE	REGEN LOSS (4250)	NO REGEN LOSS (4981)	Total
4471	BURNING FOR PLANTING	24(30)	12(26)	36(28)
4473	MECHANICAL FOR PLANTING	7(9)	3(6)	10(8)
4491	BURNING FOR NATURAL REGENERATION	29(36)	12(26)	41(32)
4493	MECHANICAL FOR NATURAL REGENERATION	21(26)	20(43)	41(32)
Total		**81(100)**	**47(100)**	**128(100)**

Figure 14. Frequency distribution of fire codes by site preparation type.

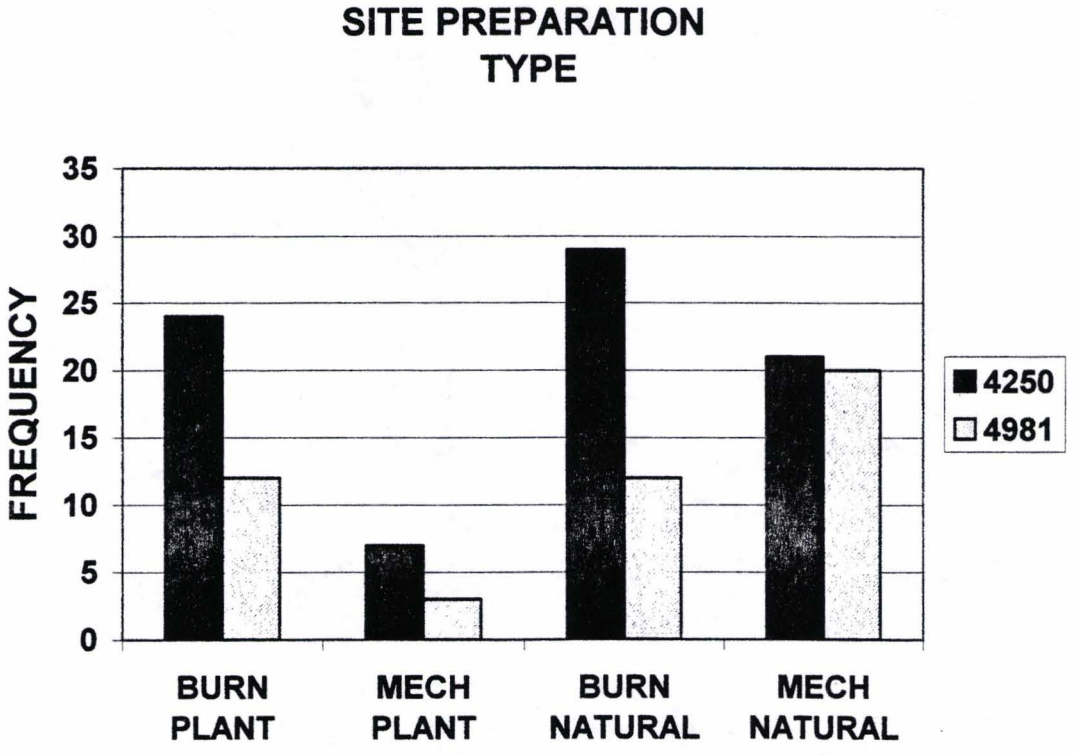

Table 15a. Frequency distribution of fire codes by fuel treatment 1 type. Number in parenthesis is row percent.

CODE	Fuel Treatment 1 Type	REGEN LOSS (4250)	NO REGEN LOSS (4981)	Total
4982	LOPPING	1(100)	0(0)	1(100)
4983	MECHANICAL PILING	4(100)	0(0)	4(100)
4984	DOZER PILING	24(59)	17(41)	41(100)
Total		**29(63)**	**17(37)**	**46(100)**

Table 15b. Frequency distribution of fire codes by fuel treatment 1 type. Number in parenthesis is column percent.

CODE	Fuel Treatment 1 Type	REGEN LOSS (4250)	NO REGEN LOSS (4981)	Total
4982	LOPPING	1(3)	0(0)	1(2)
4983	MECHANICAL PILING	4(14)	0(0)	4(9)
4984	DOZER PILING	24(83)	17(100)	41(89)
Total		**29(100)**	**17(100)**	**46(100)**

Figure 15. Frequency distribution of fire codes by fuel treatment 1 type.

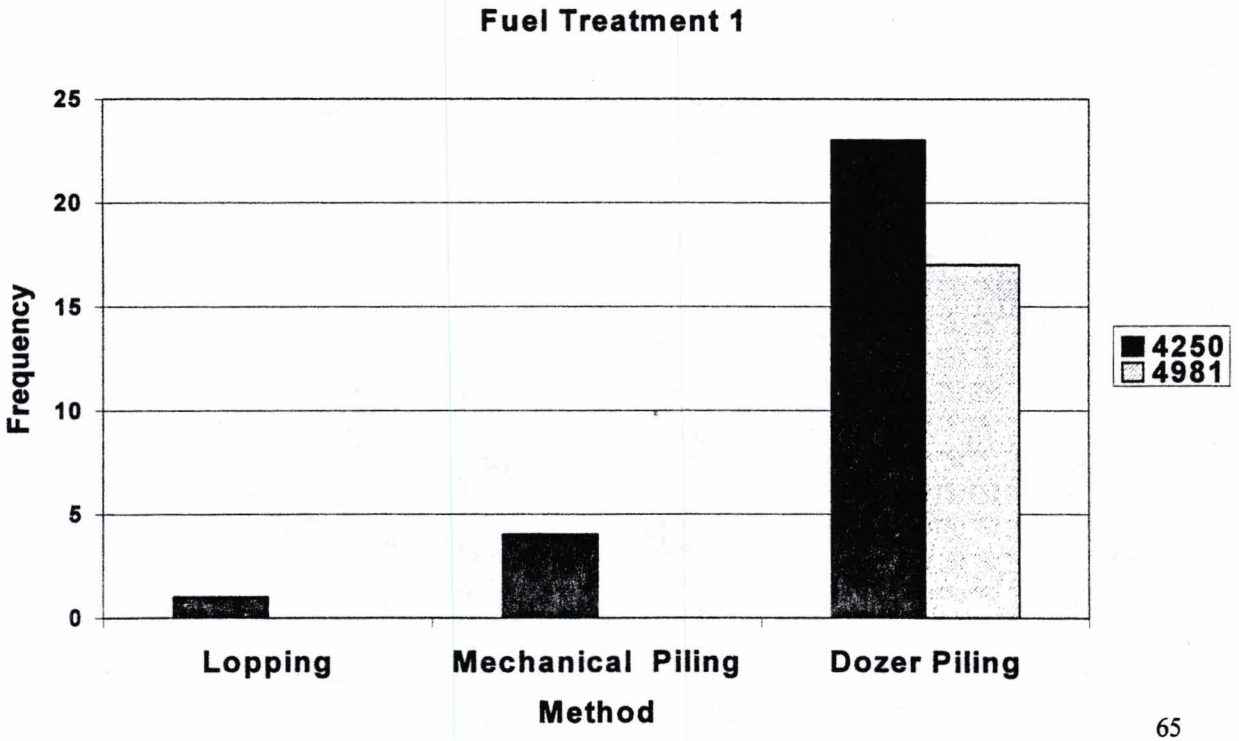

Table 16a. Frequency distribution of fire codes by fuel treatment 2 type. Number in parenthesis is row percent.

CODE	Fuel Treatment 2 Type	REGEN LOSS (4250)	NO REGEN LOSS (4981)	Total
4975	BURN DOZER PILES	21(50)	21(50)	42(100)
4977	BURN MECHANICAL PILES	2(100)	0(0)	2(100)
4978	BROADCAST BURN	38(67)	19(33)	57(100)
4979	JACKPOT BURN	1(100)	0(0)	1(100)
4980	UNDERSTORY BURN	12(75)	4(25)	16(100)
Total		**74(63)**	**44(37)**	**118(100)**

Table 16b. Frequency distribution of fire codes by fuel treatment 2 type. Number in parenthesis in column percent.

CODE	Fuel Treatment 2 Type	REGEN LOSS (4250)	NO REGEN LOSS (4981)	Total
4975	BURN DOZER PILES	21(28)	21(48)	42(36)
4977	BURN MECHANICAL PILES	2(3)	0(0)	2(2)
4978	BROADCAST	38(51)	19(43)	57(48)
4979	JACKPOT	1(1)	0(0)	1(<1))
4980	UNDERSTORY	12(16)	4(9)	16(14)
Total	**Total**	**74(100)**	**44(100)**	**118(100)**

Figure 16. Frequency distribution of fire codes by fuel treatment 2 type.

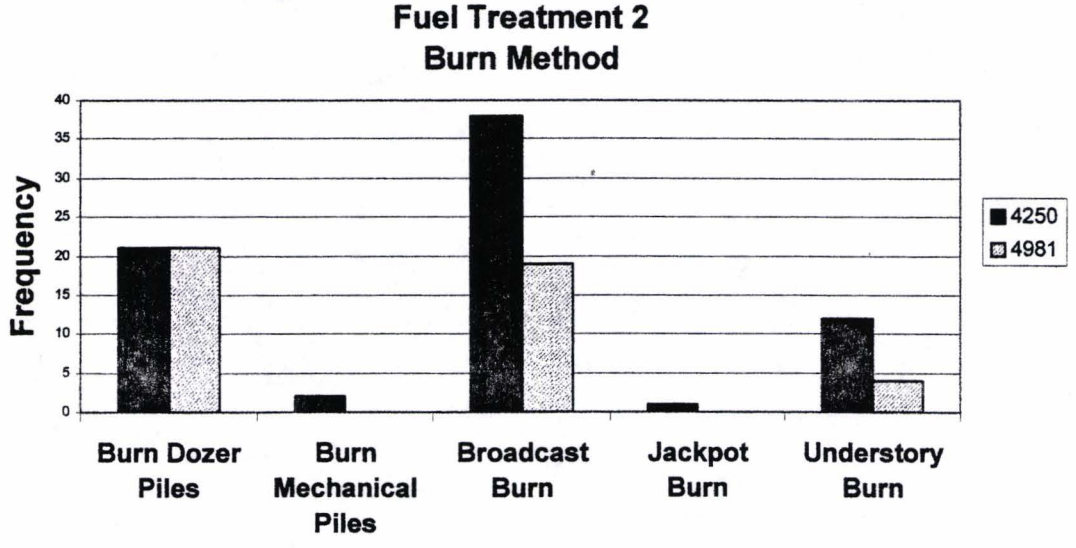

Table 17a. Frequency distribution of fire codes by fuel treatment 2 month. Number in parenthesis is row percent.

Fuel Treatment 2 Month	REGEN LOSS (4250)	NO REGEN LOSS (4981)	Total
APRIL	2(100)	0(0)	2(100)
MAY	9(75)	3(25)	12(100)
JUNE	11(61)	7(39)	18(100)
AUGUST	1(33)	2(67)	3(100)
SEPTEMBER	15(56)	12(44)	27(100)
OCTOBER	32(65)	17(35)	49(100)
NOVEMBER	1(33)	2(67)	3(100)
DECEMBER	3(100)	0(0)	3(100)
Total	**74(63)**	**43(37)**	**117(100)**

Table 17b. Frequency distribution of fire codes by fuel treatment 2 month. Number in parenthesis in column percent.

Fuel Treatment 2 Month	REGEN LOSS (4250)	NO REGEN LOSS (4981)	Total
APRIL	2(3)	0(0)	2(2)
MAY	9(12)	3(7)	12(10)
JUNE	11(15)	7(16)	18(15)
AUGUST	1(1)	2(5)	3(3)
SEPTEMBER	15(20)	12(28)	27(23)
OCTOBER	32(43)	17(40)	49(42)
NOVEMBER	1(1)	2(5)	3(3)
DECEMBER	3(4)	0(0)	3(3)
Total	**74(100)**	**43(100)**	**117(100)**

Figure 17. Frequency distribution of fire codes by fuel treatment 2 month.

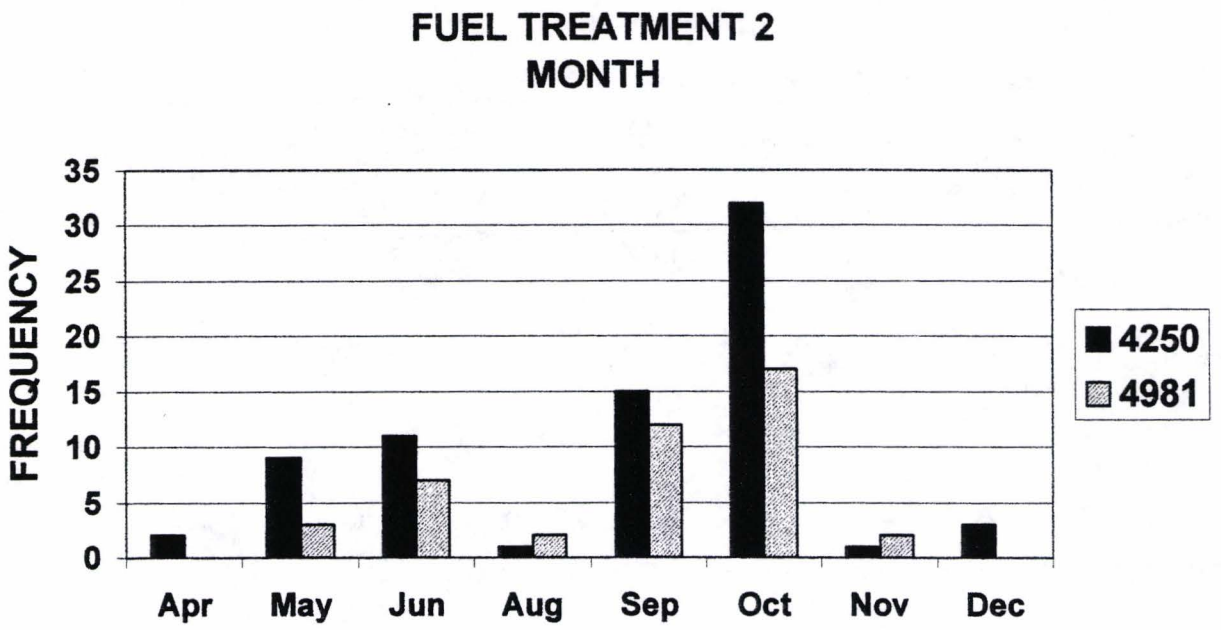

Table 18a. Frequency distribution of fire codes by fuel treatment 3 type. Number in parenthesis is row percent.

CODE	Fuel Treatment 3 Type	REGEN LOSS (4250)	NO REGEN LOSS (4981)	Total
4978	BROADCAST BURN	1(100)	0(0)	1(100)
4980	UNDERSTORY BURN	1(100)	0(0)	1(100)
Total		**2(100)**	**0(0)**	**2(100)**

Table 18b. Frequency distribution of fire codes by fuel treatment 3 type. Number in parenthesis in column percent.

CODE	Fuel Treatment 3 Type	REGEN LOSS (4250)	NO REGEN LOSS (4981)	Total
4978	BROADCAST	1(50)	0(0)	1(50)
4980	UNDERSTORY	1(50)	0(0)	1(50)
Total		**2(100)**	**0(0)**	**2(100)**

Table 19a. Frequency distribution of fire codes by fuel treatment 3 month. Number in parenthesis is row percent.

Fuel Treatment 3 Month	REGEN LOSS (4250)	NO REGEN LOSS (4981)	Total
AUG	1(100)	0(0)	1(100)
OCT	1(100)	0(0)	1(100)
Total	**2(100)**	**0(0)**	**2(100)**

Table 19b. Frequency distribution of fire codes by fuel treatment 3 month. Number in parenthesis in column percent.

Fuel Treatment 3 Month	REGEN LOSS (4250)	NO REGEN LOSS (4981)	Total
AUG	1(50)	0(0)	1(50)
OCT	1(50)	0(0)	1(50)
Total	**2(100)**	**0(0)**	**2(100)**
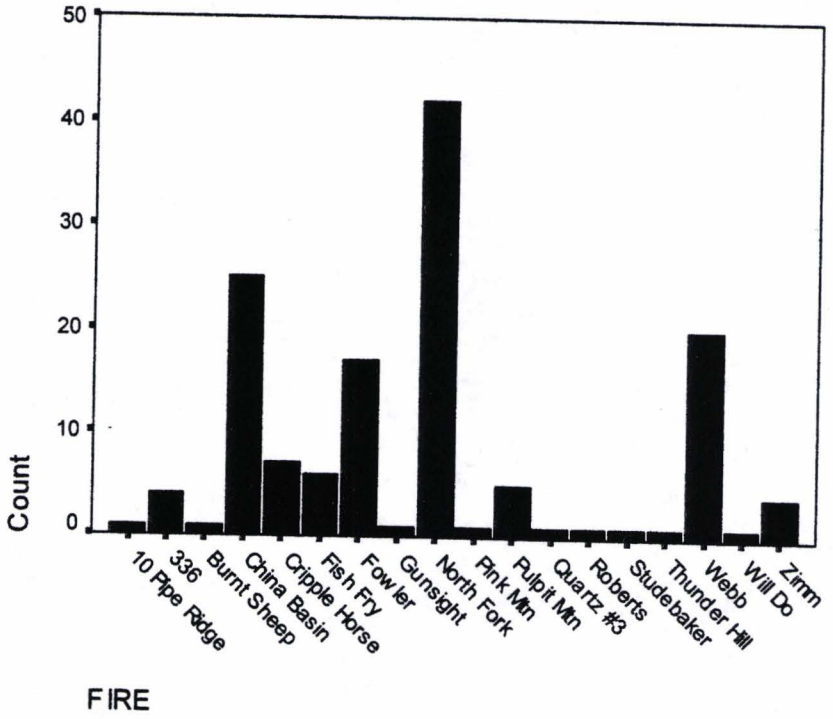
Figure 18. Frequency distribution of number of stands by fire name.